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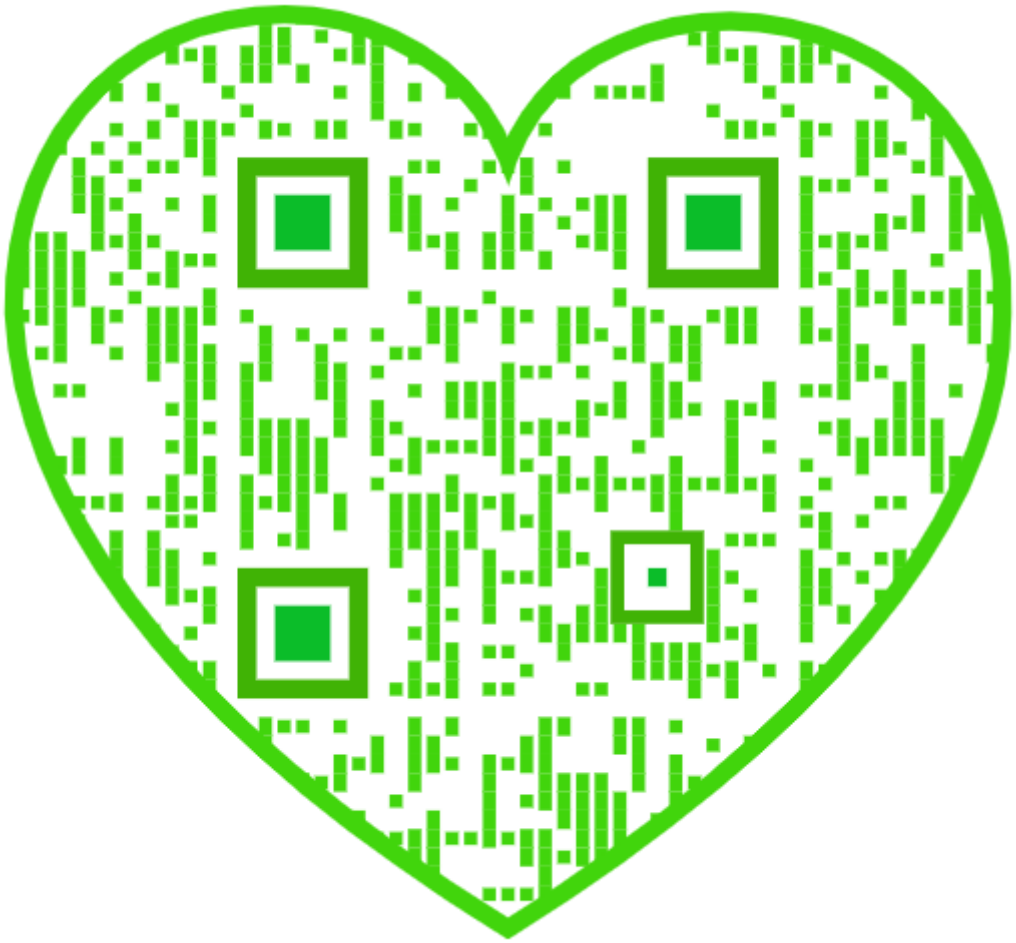
PRACTICAL POTATO CULTURE

BY

E. A. ROGERS

PRICE FIFTY CENTS



MR. E. A. ROGERS

Practical Potato Culture

By

E. A. Rogers

Brunswick

Maine

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Secretary of Agriculture.

A. L. Martin.
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Dairy & Food Commissioner.

PENNSYLVANIA
DEPARTMENT OF AGRICULTURE.
HARRISBURG

C. J. Marshall
State Veterinarian.

H. A. Surface.
Economic Zoologist.

M. D. Lichliter.
Chief Clerk.

January 29, 1913

Mr. J. B. Haines,
Bailey Building,
Philadelphia, Pa.

My dear Sir:-

I understand that you are about to publish a book on Potato Culture by E. A. Rogers of Maine.

Mr. Rogers prepared a bulletin for this Department on Potato Culture, which was published in 1910, which was very satisfactory to this Department and proved to be of great value to the potato growers of this State.

I shall look with anxiety for the appearance of your publication which I feel sure will be well received by potato growers throughout the country.

Very truly yours,

N. B. Critchfield

Secretary of Agriculture.

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Introduction

To the readers of this treatise on the potato I have but to state that I receive so many inquiries each year as to our Maine methods of growing this crop that it is impossible for me to answer and give the information asked for in a letter. Two years ago I was asked by the Secretary of Agriculture of the State of Pennsylvania to prepare a bulletin on the potato. This I did, and it was issued as bulletin No. 190 of the Pennsylvania Department of Agriculture, Harrisburg, Pa. I only had a few weeks in which to prepare this work and was unable in the short time at my disposal to make the work as complete as it should have been. Nevertheless, it was considered of value enough so that a year later the great Pennsylvania Railroad reissued it in an abridged form for distribution to the farmers along its lines, and up to November, 1911, had been obliged to print the third edition to supply the demand for it.

In December, 1911, the manager of the New England Industral Bureau of the N. Y., N. H. & H., the Boston & Maine and the Maine Central R. R. wrote, asking the author's permission to publish the original bulletin for distribution throughout New England.

This permission was readily given, for while the original bulletin was not as complete as desired, I felt that it might be of value to many. Nevertheless, I have no doubt but what it will increase the number of letters asking for information that come to me.

In order that I can fully answer these personal inquiries, I have revised and rewritten those parts of the original bulletin which I considered incomplete. I also have added a few more pages on the home garden and its protection from insects, which is growing to be of more and more importance to us each year as the cost of living increases.

I am not going to attempt to say that all the methods as laid down in the following pages relative to growing potatoes in Maine will be equally as productive in every state.

The principles of soil preparation and the use of commercial fertilizers must be the same in one state as another. So will the keeping and preparation of seed, the fighting of

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all insects without the injury to the vines, as is now so often done, be the same, whether in Maine or Colorado. The methods of cultivating may differ somewhat, depending on the amount of rainfall in different states, but even this is a mooted question. I have simply put down facts as they apply to Maine's conditions, with as great a variety of soil as will be found in any state.

They have proved sound for Pennsylvania conditions and will, I believe, prove equally as valuable for Michigan, Indiana, Ohio, Wisconsin or any other of our two Northern tiers of states. I ask my readers to remember as they peruse these pages that they are the work of an everyday farmer, and one of the objects in writing this book is to save the author's time in the busy season answering questions by letter to those who desire to learn how it is that Maine leads every other large potato growing state in yield per acre. Theory is not fact, and while theory helps the scientist on his way to work out many problems, it will not feed the nation; that is done by you and I, the hard-working farmers of this broad land.

To make many phases of the work more clear and understandable to my readers I have used as far as possible photographs of the different farm implements, each doing some portion of the work which it was designed to do.

I have taken as far as possible those makes of implements which will do the work shown by the photograph in the best possible manner, and to help out my readers who desire to purchase implements of this kind I have given the name of the manufacturers, who are in every case honest, reliable firms. I have no interest whatever in the manufacture of any of these implements, with the exception of the dry dusting machines, but give the information wholly for the benefit of my readers and a desire to make this work of the greatest possible value to them.

Yours truly,

E. A. ROGERS,

Sec'y Johnson Seed Potato Co., Brunswick, Me.

General Offices, Leominster, Mass.

GENERAL CONDITIONS

The great bulk of the potatoes consumed in the United States during the late fall and winter months

probably will be grown for a generation at least in the northern tier of states, as they are today. There are sections in most of these states where enormous quantities could be grown with profit where but few are produced today. As the population of the country increases, there will be an ever increasing demand for the potato, for there is no vegetable grown so generally used by all classes.

There is also a wide demand for better quality than is now raised in many sections, and a more intelligent system of getting them to the consumers' table, with the natural quality unimpaired, than is now the case.

The culture of this important crop has not received the attention in certain localities that it deserves, for there are but few crops grown that will so quickly respond to intelligent care and culture as will the potato. The value of the crop per acre ranks with the highest in those sections where the crop is studied and modern methods and machinery are used. That this can be made to be true in many other localities where at present the culture is limited, or if followed in the old way produces but little or no profit to the grower, few who are familiar with the subject will deny.

The following statistics obtained from the United States Department of Agriculture, Bureau of Statistics, for the year 1908, are here given, showing the relative standing of the seven leading potato states of the country, both as to acreage and yield per acre. For convenience of comparison, I give them in order of the largest acreage first:

State.	Acreage.	Average Yield Per Acre.
New York	425,000	82 bushels
Michigan	325,000	72 bushels
Pennsylvania	277,000	72 bushels
Wisconsin	252,000	80 bushels
Ohio	170,000	77 bushels
Minnesota	145,000	76 bushels
Maine	**116,000**	**225 bushels**

By this table it will be seen that while Maine comes seventh on the list in number of acres planted, she is second in point of yield, the average per acre being over three times as great in Maine as in Michigan and Pennsylvania, and practically three times as large as in Min-

nesota, Ohio and Wisconsin and 2¾ as large as in New York.

Maine, with her 116,000 acres planted, harvested a crop of 26,100,000 bushels, while Pennsylvania, with an acreage planted of 277,000 acres, only harvested 19,944,000 bushels; or, with 161,000 more acres planted, she did not harvest as many potatoes by over six million bushels. Michigan had over two and three quarters times as many acres planted as did Maine, and harvested less by 2,700,000 bushels. That this is wholly or largely the result of better climatic and soil conditions in Maine, I do not believe. The conditions in Maine, one year with another, may be, and probably are, more favorable than they rule in Pennsylvania or Michigan. I do not, however, believe that this is true of New York. From a thorough knowledge of Maine conditions, I have been able to compare them with the conditions I have found in my travels throughout New York, Michigan, Indiana, Ohio, Pennsylvania and several other states, and it is my firm belief that the attention given the culture, with protection against insects and blight, along with a crop rotation suited to the potato itself, has more to do with the great difference in yield found between Maine and those other states than more soil and climatic conditions.

In this view, I believe I am supported by the yield gotten by individuals in practically all the above-named states, who have given the potato conditions suitable for its best development, which any farmer can do in any state named, who has gotten yields from 300 to 500 bushels per acre.

If such yields as the above can be gotten in individual cases by proper fitting of the soil and fertilization, there can be no question but what the same effort put forth by the potato growers of any state would increase the yield per acre nearly, if not quite, up to that of Maine.

ROTATION

The potato grower should have a certain fixed system of crop rotation in order to get the best results. No haphazard method will pay in a series of years, and this rotation will have to be varied to suit the different localities. In the southern sections, where winter wheat

is grown, a different system will be found necessary than in northern and mountainous regions. The Maine potato grower usually has either a three or four year rotation.

First, potatoes on broken sod. Second, grain, usually oats or spring wheat, which is sown as early as the ground is in condition to be properly worked, grass and clover being sown along with the oats or wheat. Third and fourth years, hay, unless a three-year rotation is practiced, when hay will only be cut the third year, plowing under the second crop of clover for potatoes. This is sometimes varied by planting corn the second year, seeding to grass and clover at the last working of the corn, which in Maine usually comes in the first ten days of July. As fine a stand of grass and clover is usually obtained by seeding in this manner as it is possible to obtain with any system of seeding with small grains. There is one disadvantage, in that the first year's hay will contain more or less corn stubble; this is of no consequence if the hay can be fed on the farm and is not intended for sale.

This following of potatoes with corn allows an application of barn dressing to be applied to land that is in the potato rotation, with but little if any injury to the potato crop, as it will be so far used up by the corn and hay crops before potatoes will again come into the rotation that the chances of rot or scab from this cause are slight.

The application of barn manure will greatly help both corn and the newly seeded grass and clover. If oats were to be sown, it would not do to apply this barn dressing, as it is almost sure to result in lodged grain, which means a killing out of the clover in the lodged portions of the field, and a failure of the grain to fill. This rotation should do as well for other states as it does for Maine, but in the southern sections, where corn is planted on sod, followed the second year with potatoes, crimson clover, winter vetch, or some other humus-supplying crop should be sown in the corn, if large crops of potatoes are to be expected. No farmer who follows a system of rotation which places the potato second can hope to get maximum crops.

SOILS FOR POTATOES

The potato must have well-drained soil; no amount of care in selecting seed and cultivation or surface drainage after planting will avail, the potato will not produce a paying crop of nice, marketable tubers in a soil filled with stagnant water. The deep sandy or gravelly loams are without question the best. Not only will the potato, as a rule, grow better in this kind of soil, but they are more easily worked. The successful potato grower knows that it is largely a question of doing the work at just the proper time, and a deep sandy or gravelly loam can be worked sooner after rains, and little delay will be caused in the work by our short summer rains on this kind of land. Clay loam, if not too heavy, will produce just as many bushels per acre as will the lighter soils and of just as good quality, provided the soil is well drained; the disadvantage of the heavier soils is in the working of them in wet weather, which may delay planting in spring, and prevent cultivation to such an extent that the weeds may get a start, not to be overcome with any system of cultivation, except hand-work, which is too costly and slow to be considered in these days of high-priced labor. Some of the largest yields I have ever seen, running from five to six hundred bushels per acre, and of the very finest quality, were grown on clay loam soil, and a farmer having such a soil need not despair of entering potato growing in competition with his more favored neighbors, who may have an easily worked sandy or gravelly loam.

UNDERDRAINAGE

The value of underdrainage to land intended for potatoes cannot be overestimated. In many cases the whole cost of putting in a system of tile underdrain will be more than paid back by the increase in the first year's crop. In fact, if there were any places in the field where water was wont to stand after rains, this is most sure to be the case. When we consider that a properly laid system of tile drain will last for a lifetime or longer, with its beneficial effects on all crops every year, it becomes one of the most profitable investments any farmer can make. The farmer will understand that this applies especially to those fields which are springy or with depressions in them where the water stands after rain. Such places

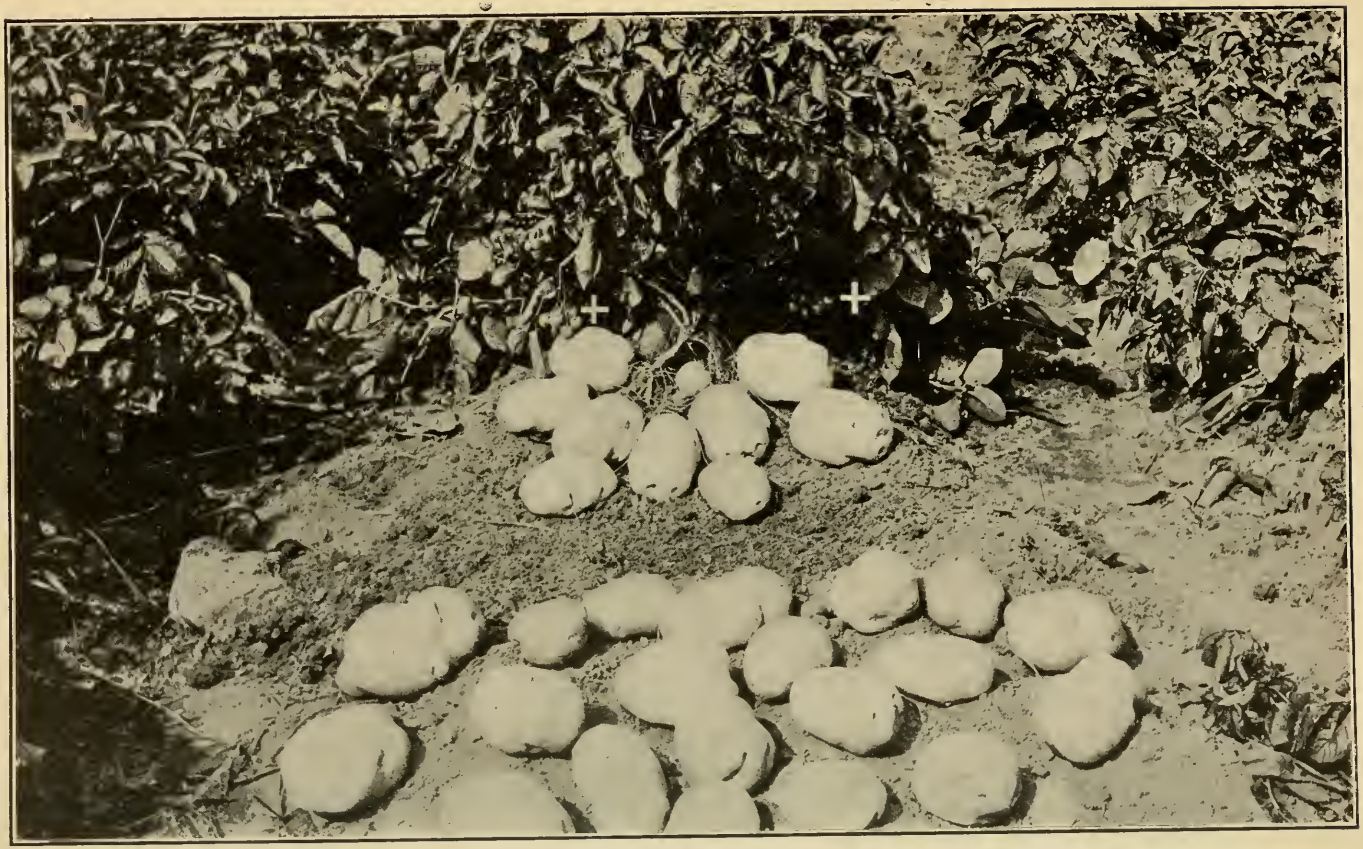

Photo No. 2. Showing a perfect development of the potato plant. Ideal healthy vines with the true seed as shown in the seed bolls and a paying bill o' potatoes. Clusters of seed bolls marked by X.

will not produce a paying crop of potatoes, no matter how much care is given in the way of fertilization, cultivation and spraying, until the surplus water from those places is removed by underdrains. The increase in the crop from these underdrained wet places is only a part of the value of this work to the potato grower, as a wet, springy place or depression where the water may collect after a rain will so reduce the vigor of the crop, if not killing it outright in these places, that blight will very often start; spreading from these to the higher portions of the field, with the result that the whole field will be ruined when, but from these sources of infection, it would have escaped.

An undrained sag in a potato field is a menace to the whole field, for it is a breeding place for the late blight or rot, and furthermore, even in a dry season, when potatoes can grow in such a place, they are seldom fit for market, being rough and ill shapen and of poor quality.

PREPARING LAND FOR POTATOES

In taking up the preparation of land for white potatoes I shall have to divide it into several sections in order to suit each kind of soil and to properly describe how to work up the vegetable matter that grows on each.

To the average grower the preparation of a potato field is of more importance than the kind of soil, always provided it is well drained. I believe we have very little workable land which cannot by intelligent methods be made to produce a paying crop of potatoes. Land which is too wet needs drainage; land which is naturally too dry can, by supplying it with plenty of humus or vegetable matter, be made to hold plenty of moisture to produce a paying crop.

With the potato, I believe, more than with any other crop does success depend on the man than on the soil itself. Potatoes need a large amount of available moisture, not stagnant water which excludes the air, but moisture in such a way that air can circulate freely through the few inches of the top soil and the more vegetable matter or humus, the more moisture it can hold and still have this air circulation. There is no crop I know of that will so rapidly use up vegetable matter from the soil as will the potato, and the more humus the soil contains the greater will be the resultant yield; and the lack of humus or vegetable matter

in our soil is, I believe, one of the greatest drawbacks the potato grower has to contend with today.

For this reason, in the chapters that follow, I shall treat fully of the different methods by which the grower can obtain this vegetable matter with the least possible expense of time and labor. Again, after the grower obtains this, it is equally as important, if the very best results are to be obtained in crop production, that it be properly incorporated into the soil.

The system of planting corn on sod, following the next year with potatoes, deprives the potato of the vegetable matter it so badly needs, and in many cases reduces the yield of tubers below a paying basis, and one of the greatest problems of the potato grower is how at the minimum cost to supply this vegetable matter.

In those sections where crimson clover can be sown at the last working of the corn with a fair prospect of getting a good growth, it will be found to be of benefit, but in the more northern sections and mountainous portions, where corn is not so much grown, the same system of culture and rotation that is practiced in Maine can be followed successfully with some slight variations.

On an old meadow which has been down to grass for several years and covered with a heavy sod, there will be found to be vegetable matter enough in the sod to produce a large crop of tubers if a liberal application of chemicals or ready mixed commercial fertilizer is used.

Having such a sod, the next thing is to so prepare it that the potato crop will derive the maximum benefit from it. The chapters immediately following will give some of the best known methods.

Subduing a New England Witch-Grass Sod

This is known locally also as quack, couch, wild rye and Johnson grass, and the methods described for fitting a sod of this kind for potatoes is equally as good for any other kind of grass, but usually the work does not have to be so thoroughly done, therefore is not so expensive. Land with a tough witch-grass-bound sod, such as is found in New England, must have a different and longer preparation before it can be planted to potatoes than any that is usually found in most other sections of our country.

Again, the more northern sections can and should use

a different method than would give the best results farther south.

While witch-grass is not confined wholly to the New England states, there is practically no farmer there but what knows what it is, with its long white roots with a very sharp point which will grow right through a good sized tuber. It starts its growth early in the spring and if the roots are cut or broken will send up new stalks from every root joint. Probably it has driven more New England boys from the farms than any one thing, and where allowed to get a good start in a potato field makes it impossible to dig such a field with any digger yet made with any degree of success. Witch-grass is one of the greatest curses to New England agriculture and one of the greatest blessings also (when you have gotten rid of it), for one having a good sod of this kind is sure of raising fine potatoes if he will simply kill it out and make plant food of it. Potatoes will grow smoother upon it than they will on a clover sod and be of the finest quality.

To subdue a field of this kind the work must be begun the year previous to planting potatoes, and if the land is in grass this should be cut just as the witch-grass begins to blossom, as the roots then seem to be at their most exhausted period. As soon as the hay is gathered in, work should be commenced to kill out the grass, and on land free from stone a double cutaway harrow is a fine implement. In using this method the ground should not be plowed until the sod has been entirely killed out by harrowing.

The disks should be ground sharp and the harrow weighted, and if three or four horses can be spared for the harrow the more quickly and thoroughly can the work be done. The field should be gone over both lengthways and crosswise, cutting us as deeply as the harrow will do the work. The field should be gone over at least once a week with the harrow for the first few weeks and then as often as any of the roots show any signs of sprouting, even as late as October. I have at this stage sown winter rye and plowed down in the spring, but there is most sure to be some of the witch-grass roots which would not be quite dead and would make growth after the rye was sown, springing into vigorous life after the rye was plowed down in the spring. Thus, one wanting to make a sure kill of the grass had better leave the rye out even if there is some loss of nitrates

by leaching during the winter. There will be such a mass of dead vegetable matter that the soil is not exposed to winter leaching like plowed land, which will make humus, pulverized and mixed all through the top, five or six inches of soil. As soon as the soil can be worked in the spring start the harrow again going, both crosswise and lengthways, as before. If the work has been done thoroughly there should not be a live root on the field, but there will be an immense amount of dead vegetable matter.

Photo No. 3 shows a double-action cutaway harrow made by the Cutaway Harrow Co., Higganum, Conn., cutting up and pulverizing a heavy timothy red top and witch-grass sod in early September, 1912, for a crop of potatoes in 1913 on the author's home farm, Mere Point Brunswick, Maine. The reader will note the mass of vegetable matter that has already been worked up. This in itself is a good protection against winter leaching.

The field is now ready to be plowed, and this should be done deeply, not less than eight, and ten inches is much better for potatoes, turning down this top soil with its mass of vegetable matter into the bottom of the furrow.

Go over the field both ways again with the double cutaway, followed by the smoothing harrow, and we have the whole depth plowed a finely pulverized seed bed with the witch-grass sod entirely killed and in the best possible place and condition to make the potato crop grow. It will now act as storage for moisture and not prevent the subsoil moisture from coming to the surface by capillary attraction, as would have been the case had it been plowed down without being first cut up and mixed with the soil.

No harm will be done on land worked in this manner by plowing as deep as mentioned above, even if an inch or two of the hard subsoil has been turned on top. We have got to have a few inches of the soil that is on top for our dust mulch, and this subsoil we have turned up will do nearly as well as any and gives the potato crop all the nice soil to grow in.

The cost of working a witch-grass sod in this way is about ten dollars per acre, previous to plowing. The work after plowing is less, as less discing is needed to make a perfect seed bed. The yield per acre is very much more, as the intense cultivation required to kill the grass roots makes the soil more productive, and the reduction in the cost of handling the crop after planting more than offsets

Photo No. 3. Photo taken Sept. 5th, 1912 on the home farm of the Author showing the splendid work of the Clark Cutaway double action harrow in pulverizing and fitting a tough New England Witch grass sod for a potato crop in 1914. This harrow is manufactured by the Cutaway Harrow Co., Higganum, Conn.

the cost of the work to kill the grass.

Handling a Northern Timothy, Red Top and Clover Sod

In describing the working up of a witch-grass sod the everyday farmer will know that the witch-grass seldom grows entirely alone, but has mixed with it timothy and usually some red top, and at times some clover, although the clover stands but little show when the witch-grass is thick or has had time to form a heavy sod. Hence, any land that has the witch-grass in it should be worked as described in the previous chapter.

A good timothy and red top sod can be as thick on the ground as the quack, but is not usually as deep, and as this can be readily killed out, the harrow need not be started until spring, when the work can be thoroughly done unless the land is intended for very early potatoes, when it is better to cut it up late the fall previous. No man who has not thoroughly tried this cutting up of the sod with a good cutaway harrow previous to plowing can begin to realize the benefit it is to the crop, the mixing of this decaying turf all through the soil and then plowing down works favorable to the crop in many ways.

The old method in Maine was to break the sod late in the fall. This, if followed by a dry season, was much better than turning it down just before planting in the spring.

None of our general field crops need as deep plowing to do their best as does the potato; to break and turn down a sod in the fall and plow the land as deeply as the potato needs to do its best in is to put all that vegetable matter too deep into the soil for the best results. No harrow can be worked deep enough to touch it, and the result is that only a few inches of the top soil gets worked with the harrow at all, leaving this blanket of turf to retard the subsoil moisture from coming near enough to the surface to benefit the growing potatoes as it should and further denying them of the plant food the sod contains, which they could have used had the sod been properly worked up previous to plowing.

However, it is much better if a sod is not going to be cut up with a harrow to plow it down the fall previous to planting, then to wait until spring, especially if followed by a dry season. Land broken in the fall gets settled down together and decay sets in from the rains of winter and spring, so that there is much better capillary connection

through the turf than if the same field was spring plowed, and while it cannot be harrowed as deeply as it should be to get the best results in crop production, the same would hold true if it were spring plowed. In turning down a heavy sod in the spring without first cutting it up and mixing it with the first five or six inches of soil, we are denying the crop to be planted, whether potatoes or anything else, not only of the greater part of the plant food the sod contains, but we are putting it in the worst possible place and condition to retard that crop's development, for with dry weather coming on the sod will not decay, and until it does none of the subsoil moisture can get near enough to the surface to be of any use in dissolving plant food for the crop to drink up.

This working will apply equally as well to any clover field, either crimson or northern, wherever grown, South or North. It is a decided advantage in sprouting and killing millions of weed seeds before the crop is planted.

Subsoiling

We see but little of late years about subsoiling, and there seems to be a sort of fad to plow very shallow for most every crop.

This is a better system for corn and the small grains than for the potato. The deeper soil can be worked for potatoes the better, if it is done right. There is always a right and wrong way to do most any kind of farm work. Subsoiling, if done when and as it should be, will greatly increase the yield of potatoes, enlarge the water holding capacity of the soil and improve the crop of grain and hay which follow.

Let a farmer take a field where the soil is somewhat thin, and which he had been plowing for years from five to not over seven inches, and put on a heavy team with a big plow, and plow twelve, turning up from four to five inches of hard subsoil with all of his good soil underneath and there could be but one result, and that a bad one. Yet that subsoil contains elements of plant food in much more abundance than the top soil which he has turned down, but it is to a very great extent deficient in humus or vegetable matter, and it will make but little difference to most crops how much potash and phosphoric acid it may contain, it is unpalatable to them, and they will not thrive upon it until in course of time it becomes filled with decaying vegetable matter.

On some farms, cultivated as they are, this might take years.

Therefore, unless a farmer clearly knows what he wants and just how to go about it, he had better let subsoiling alone.

Dig a well, twenty feet or more deep, in my section of Maine, and take the clear blue clay from the very bottom of it and spread it on the ground and clover will come up and grow finely upon it, but not many other plants would. I have pulverized clear blue clay to the depth of two feet and planted potatoes in it and they have done finely, and no smoother, finer tubers were ever taken from the ground than these out of this clear blue clay.

I cite these cases simply to call attention to the possibilities that lie in our soil below what the common farmer is cultivating.

When the potato grower has worked up his sod as I have described under "Subduing a New England Witch-grass Sod," and starts his plow at the depth I have named, if he will follow with another team with a good subsoil plow, running it as deep as he can, the deeper, the better, but not turning this up on top of the other soil, simply breaking it up and loosening it in the bottom of the furrow, he **will find that not only will his potatoes pay him a big price for the work done by an increased yield, but the other crops that follow will for years do the same. By doing this in this way he has greatly enlarged the soil's water holding capacity, which in a dry season may for this reason alone make him a good crop of tubers, when without it his crop would have been a failure.**

Potato roots will penetrate deeper into this in a dry season than many will believe.

When seeded to the grasses and clovers the clover roots will fill this full of roots, gradually filling it with humus as they decay, deepening and making the land more productive as the years go on.

I suppose I have heard hundreds of farmers say that their soil was not as deep as it used to be, and almost invariably by inquiry I find that shallow plowing for corn and small grains has been the rule.

I believe that in thousands of cases the growers of corn and small grains could, by working their land over as above described, planting to potatoes the year they sub-

soiled, increase the production of their farms many per cent over what they are now getting. Subsoiling, when rightly done, on many soils is a decided benefit.

HOW TO GET HUMUS

The control of moisture in land to be planted to potatoes is of great importance and cannot be secured by drainage alone, as it is largely a matter of the humus-content in the soil. One hundred pounds of clean, dry sand will take twenty-two pounds of water to saturate it; one hundred pounds of our ordinary clay loam soil, perfectly dry, will take fifty-six pounds of water before it will become saturated, while one hundred pounds of perfectly dry leaf mold soil will take one hundred and ninety-six pounds of water to saturate it, or nearly nine times as much as it takes to saturate an equal number of pounds of sand, and three and one-half as much more as it takes to saturate our ordinary clay loam soil. With a soil deficient in humus, no amount of cultivation or commercial fertilizer in a dry season can make it produce a paying crop of potatoes, while a soil filled with humus can be made by cultivation to produce a paying crop even in a season of practically no rain. A clay loam soil, filled with humus, can be worked much quicker after a heavy rain than the same soil which is deficient in it, and the capacity of the humus-filled soil to hold moisture is so much greater, that with intelligent shallow cultivation, a good crop is practically assured.

The control of moisture is not the only advantage of having a soil filled with humus. The rock-formed soils of the eastern portion of our country are filled with mineral plant food. It has been claimed by leading scientific men that the top eight inches of our heaviest loams contains potash enough to raise maximum crops from two to four hundred years, and phosphoric acid from one hundred and fifty to three hundred years, but they are locked up in an insoluble form; a wise provision, indeed, to prevent man from leaving the face of nature a barren waste. Fill a soil with humus, which is decaying organic matter, and the acids formed in this process help to break down and set free some of this locked-up plant food. The second eight inches contains as much or even more mineral plant food than the first. The

productiveness of our soils depends more largely upon their humus-content than upon any other one thing, and one of the first objects of the potato grower should be to fill his soil with this decaying vegetable matter.

In studying to replenish the organic content of our soils, we should keep in mind those plants which will also supply nitrogen, as this is the most costly element of plant food we have to buy, and both humus and nitrogen can be supplied to our soils by the legumes. Of these, alfalfa stands at the head, but owing to the short rotation usually carried out by the potato grower, it is but little used. With those who have land enough to adopt a five-year rotation for their potato crop, and facilities for keeping stock to use up the alfalfa on their farms, I know of no crop which will give better returns. Alfalfa makes a very large root-growth, which will penetrate deeply, even into a hard clay sub-soil, bringing up fertility from below, increasing greatly the water-holding capacity of the soil, and at the same time gathering and storing the costly nitrogen. None of our clovers have the soil-renovating capacity equal to alfalfa, and the potato grower, having a three-year-old alfalfa sod to plow under, can grow a good crop of potatoes with the smallest amount of commercial fertilizer. Alfalfa can be grown on most any well-drained soil, and as it seems to thrive best when sowed in early August, it can follow early potatoes.

The ground should be thoroughly worked previous to sowing the alfalfa to kill out the weed seeds; this, of course, would be the case on land planted to early potatoes, and this is one of the essentials, as the alfalfa plant, when young, is easily smothered out by weeds. Taking a field which has been worked in this manner and applying a liberal amount of lime, not less than one ton per acre, well harrowed in with from one to three bushels of inoculated soil from a thrifty alfalfa field, sowing twenty-five to thirty pounds of the best northern-grown alfalfa seed about the first week in August, there will be no trouble in getting a stand of alfalfa which will last three years, giving a large amount of hay and putting the soil in the best possible condition for the growing of potatoes.

Next to alfalfa, a heavy clover sod to plow under not only furnishes a large amount of vegetable matter,

but also many dollars' worth of nitrogenous plant food. Some authorities claim that a second crop of clover, with its root system, leaves in an acre of ground from 150 to 200 pounds of nitrogen, which, at the price the farmer has to pay, of eighteen to twenty cents per pound, would amount to from twenty-seven to forty dollars in nitrogen, and the mechanical effect of plowing under this second crop of clover and sod, while not as great as with alfalfa, would be worth as much as the nitrogen to the potato grower. In many sections clover does not grow as well as it formerly did, and owing to this failure, many farmers have entirely stopped using it in their rotation, which must result in a great loss to the productivity of their farms.

From my experience, there are two main causes for this failure of clover to grow, and I think these two will prove to be the case in ninety out of every one hundred cases, taking the country as a whole. These are, first: The lack of lime; clover needs a great deal of lime. Burn clover hay and a certain per cent of the ashes will be found to be lime, which shows that the plant needs more or less in its stock-growth, and unless lime is present in the soil, the bacteria, which lives on the clover roots and gathers nitrogen from the air for the plant to use, cannot live, or at least will not develop to the extent of being of much use to the clover crop. Second: If, after applying lime, the farmer still finds that his clover refuses to grow, he may be very sure that an application of phosphoric acid will be the one thing now lacking to give him as bountiful crops as he has ever grown in the past. The potato grower cannot afford to do without one of these two crops, alfalfa or clover.

WINTER VETCH.

Next in value to alfalfa and clover as humus producers, I should place winter vetch, especially for the northern states. This is sown with winter rye by a good many, as the rye will hold the vetch up, it is easier to plow under. In my experience, to sow the vetch with rye brings the seeding of the vetch too late to get as good stand as is to be desired, although many do this with good results. In the more northern states, I believe July to be the best time to sow winter vetch. Vetch has

one drawback, while it is one of the very best soil improvers known to agriculture today, unless handled rightly it can become a troublesome pest in our fields. This is one of the reasons I dislike to sow it with rye, as sown as late as the rye will have to be in order for it not to make too large growth before winter, it is seldom that all the vetch will sprout and grow the first season, but will keep coming up for two or three years at least, as soil and weather conditions become favorable to it. This will bring more or less of it over into the grain and hay crops, and while not so bad to have in the hay, especially if the hay is to be fed on the farm, it is undesirable to have in the grain, from every point of view.

Again, as vetch ripens more or less of its seeds early, it is most sure to reseed itself in the hay field.

I have one small patch, which was sown to vetch alone about September 15, 1909. The weather being somewhat dry, the germination was not of the best, and it made but little growth that fall, but what was there developed finely the next spring, and by early June I had all that was possible to turn under with a big breaking-up plow. Corn was then planted, and at every cultivation a liberal sprinkling of vetch plants was noted coming from seed which failed to sprout the fall previous. The following season, 1911, it was again plowed and planted to melons, and a goodly number of plants developed after the last working of the melons. Some of these developed into the largest, finest vetch plants I have ever seen, there being individual specimens by October 20th that measured over 8 feet across, forming a fine, close mat over the soil; as fine a winter covering as I have even seen.

None of the plants were ever allowed to seed, so there can be no doubt in this instance but what all came from the first sowing of seed in September, 1909. Those who follow potatoes after corn can sow the vetch in the corn at the last working in July, and unless the season should finish very dry, would be almost sure to have it all germinate. Sown at this early date, not near the amount of seed would be needed per acre as is usually called for. The plants would spread out over the ground, covering it nicely and make a vigorous and early start the following spring, and excepting where very early potatoes were to be planted, would give a large amount

of highly nitrogenous vegetable matter to plow down, and early enough in the season for any except the very early potatoes.

Rightly handled, there need be no trouble of having it become a pest, and as it can be successfully grown in the northern states, it takes the place in the north that crimson clover occupies farther south. A farmer having a field he wishes to plant to potatoes, which is deficient in vegetable matter, can get a larger amount of highly nitrogenous vegetable matter in a shorter time with vetch than any other plant I know of, but I would advise, in the northern states at least, that it be sown in July or August.

WINTER RYE.

Probably winter rye is one of the most, if not the most largely grown crop for plowing under green that we have.

The fact that it can be sown very late in the fall is perhaps one reason for this. It needs only to get well sprouted to pass through most any winter, and will make a good growth even on poor soil.

The amount of nitrogen it will return to the soil is, of course, small, as compared to the clovers, vetch, peas or beans, but with it one can greatly increase the humus content of the soil, which is one of the first requirements in building up top-worn or run-out soils.

With a liberal application of barn dressing, I have had it make a growth by early June of over seven feet, and this on poor soil.

A growth of this kind is not to be desired, for while it can be plowed down as easily as a shorter growth, it is apt to be woody, and does not decay very readily in the soil, and in case of dry weather following, it holds up the furrows and dries out the soil, to the injury of any crop planted or sown immediately following its turning under.

Probably the best stage of growth to plow down is when the rye is about twenty inches high, before it commences to head out. For this reason it can and should be sown much thicker when intended for this purpose than if desired to ripen for grain.

Humus is so badly needed in poor, thin soils that a whole season had better be given to filling the soil on

a field where potatoes are to be planted, if a profitable crop is to be expected.

If some barn dressing can be spared to give the rye a good start there will be a large amount ready to plow down by the last of May in our Northern states, then Japanese Millet can be sown, and by August 20th a much heavier crop of Millet will be ready to turn down than we had of rye. Now, if winter Vetch is sown, there will be a heavy crop of this ready the following spring, in ample time for a medium, early or late crop of potatoes. By this means the soil will be filled with vegetable matter, and a part of it at least containing a large portion of nitrogen. To be sure, one season's cropping has been entirely given up to this work, but it means so much larger crops in the years to come that one can hardly afford not to do it.

It is a comparatively easy matter for the thoughtful farmer to keep the humus content of his soil up to where it will produce good crops after it has once been brought up to that desired state, but unless a season is taken for this work in the beginning, the average man will crop it for years, getting only barely enough to pay him for his labor, when it might have been growing him immense and paying crops every year. To start with a thin soil that will only produce a small crop of rye, and turn it down and crop it with potatoes, is to use up practically all the vegetable matter we have got with the rye, which would not be enough in any case to grow a paying crop of potatoes, and the soil would be in practically the same condition as at first. As this would be the case each year, no great gain towards building up the soil to where it could produce maximum crops can be accomplished unless one season in the beginning be taken for this purpose.

The potato grower who is using commercial fertilizers should remember that he must have a large supply of humus in his soil, or he will get but little benefit from the use of the fertilizer used, and he, of all men, cannot afford to neglect adopting a system to replenish this moisture-holding, life-giving quality to his soil.

TWO MAIN CAUSES OF THE DETERIORATION OF THE POTATO

Within the memory of living men, all one had to do

to raise an abundance of potatoes, was to plant them; it did not much matter how, as long as the seed was covered by soil. Methods of culture, which at that time produced a large crop of tubers, if followed today, would hardly pay for the seed planted. The vigor of the potato in those days enabled it not only to produce an abundant crop of tubers, but to produce its true seed under the worst cultural methods. **The date of the decline of this vigor was the arrival east of the Colorado Potato Beetle. The injury done by this insect in stripping the vines of their leaves was one of the prime causes of this loss of vigor; another, and far greater cause, was the use of Paris green to kill the beetle and their larvae. These two causes, one destroying the foliage of the plant entirely and the other poisoning the life of the plant by the absorbing of arsenic, acting year after year on practically the whole potato crop of the eastern part of the country, did an incalculable damage to the vigor of the potato.** So much has the old-time vigor been impaired, that there are but few of the younger generation of farmers who have ever seen a potato boll, the true seed of the plant, the plants not possessing vitality enough to produce a good crop of tubers and the seed boll also. See photo No. 2.

That the habit of producing seed bolls is more pronounced in some varieties than in others no one who is familiar with the subject will deny. There are some varieties which possess great vigor, but little in the line of producing tubers, especially of good quality, that grow the seed bolls even under the vigor-destroying conditions I have named, yet these are of little use to the grower. On the other hand, many of our best varieties, in point of yield and quality of tubers will, if given proper culture and protection from insects and blight in a manner which will not in itself injure the vines, produce many of the seed bolls.

There has not been a year for fourteen years when I have not been able to pick seed bolls in more or less abundance from varieties that are of the very best quality for table use and largest in point of yield of tubers. New varieties have been constantly brought forward, many of them of great promise and vigor, only to run out in a few years, chiefly from the causes above given, but helped along in many minor ways. Many farmers

Photo No. 4. Showing fine top development from the effects of Bug Death at the rate of 700 lbs. per acre in three applications. This on old pasture ground without manure or fertilizer. Johnson Seed Potato Co's Experimental Fields.

saved and planted only culls; these gave them good results years ago, before the bug and the poison had destroyed the old-time vitality, but will not, except in rare instances, give a paying crop today. This is true also of many of the older varieties which have so far lost their vitality, that it is practically useless to try and bring them back to productivity equal to some of the newer varieties. **There can be no question but what there are thousands of farmers today planting potatoes of so low vitality that it is an impossibility for them to raise a paying crop of tubers under any system of cultivation and protection from insects and blights, even in a favorable season. The remedy for the more Northern states is to get some newer strain and make careful selection each year from the best and most vigorous hills, coupled with a system of protection to the vines against insects and blights that will not in itself destroy the vitality of the plants.** Farther South, where the soil and climatic conditions are more unfavorable, there was a still more rapid decline, **and even in those sections where the second crop is grown for seed there is a disposition to get Northern-grown seed every few years as a new start, in order to keep up the vitality. There has been a widespread effort on the part of some of the Ex. stations in the last few years to get a potato of large yielding capacity and of good table quality, that is blight-resisting, but, so far as I am able to learn, with but little success, owing, I firmly believe, more to those having the work in charge failing to realize the deadly influence the arsenical poisons have on the vitality of this plant.**

As a proof of my contention along this line, I refer my reader to Fig. 4 of a field of Green Mountain, Jr., potatoes, which is a four-year-old seedling, having been originated by W. E. Johnson, of Bowdoin, Me., in 1905. The parent stock had been carefully protected from blights and insect injury without the use of any arsenical poison for several years previous to producing the seed boll from which the Green Mountain, Jr., was originated.

This field was planted on an old run-out field or knoll, too poor to produce even a fair crop of weeds, and was given no fertilizing material whatever, but was protected from insects and blight in the same manner as its parents had been without the use of the arsenical poisons. As

the reader will note from the cut, there is the most perfect development of vines and bloom possible to obtain, and this in the face of the most severe drouth Southern Maine has known in the memory of her oldest living inhabitant. The yield per acre of 354 bushels, while it would not be considered remarkable on a good clover sod with liberal fertilization in a year of normal rainfall, shows to what extent we can bring back the potato to its old-time vigor when we get back to first principles.

Fig. 5 shows the field at digging, October 15th, 1909. If a blight-proof potato is ever found, it will be developed along these lines, as it is a practical impossibility to produce a blight-proof variety when the methods of culture are such that every year saps to a greater or less extent the original vitality. More than this, there is little hope of getting a seedling from a seed boll grown on plants that have had their vitality weakened by arsenical poisoning, that will develop vigor enough to be blight-proof, but the plants producing the seed boll from which we will get, if we ever do, a blight-proof variety of good yield and quality, must have behind them a series of years of unimpaired vigor, which can never be obtained if insect injury or arsenical poisoning is allowed.

The orchardist of Colorado has found to his sorrow that the use of Paris green has poisoned, not only his trees to their death, but his land as well. If we had the vigor in our potatoes today we had forty years ago, before the use of Paris green, with the methods of culture and fertilization we are now giving them, I believe we are putting it low to say that the yield would be double what we are now getting.

POTATOES FOR SEED

As I have shown in the previous chapter, "Two Main Causes of the Deterioration of the Potato," that seed of strong vitality is of vital importance to the grower, the losses from poor seed would be staggering if fully realized. Many a farmer has given up the planting of this crop, with the idea that his land was not suited to it, when a successful grower on other soil would have had no better success with the same seed.

I have carried on experiments along this line for years, some of which have cost me many hundreds of dollars, and in spite of fertilization, cultivation and protection against

Photo No. 5. Showing crop dug from vines as shown in Photo No. 4 Yield 354 bu. per acre. In this case largely the result of the heavy application of Bug Death.

insects and diseases, the fact remains that the yield is largely governed by the seed we plant. No amount of care can produce a good crop from a field that has come up weak and spindling. While such a state of affairs might, and does sometimes happen from other causes, it is mostly the result of poor seed. The true seed of the potato is in the potato boll, and the tuber is merely an enlargement of an underground stem, and as such it partakes of the character of the vine that produced it. If the vine was vigorous with ability to resist disease, just so sure will that tuber, if properly stored and planted, produce the same type of plant the next season, if kept free of all disease. "Like begets like," and if tubers are saved for seed from little, weak spindling vines, we will have little, weak spindling vines in profusion the next year. It makes no difference whether those tubers come from vines weakened by disease, insects, climate conditions or arsenical poisoning, the vitality is lowered, and while extreme favorable soil and weather conditions will help greatly to produce a good crop from this kind of seed, the fact would remain that good seed planted on the same soil under the same conditions would have produced a much better yield. Potatoes grown in the South rapidly lose their power to produce tubers, and it is seldom of much use to plant them even the second year. There is a belt that is too far north for the growing of the second crop for seed, and too far south to plant their own raising, which has to buy nearly all Northern-grown seed every year. To the grower who has to buy new seed every year from the North, it is of great importance to him to know something of the growing of that seed, and it is not out of place to point out a few methods in the growing, which the buyer should demand of the Northern seed grower.

Good seed is worth all it costs to grow it, but poor, weak seed is dear at any price. There is a widespread practice in Northern Maine of planting second-size potatoes without much attention being given to whether they come from vigorous hills or not. This is all wrong. Second-size potatoes taken from the bin year after year, can result in only one thing, the early running out of the variety. Second size potatoes are all right for seed, provided they grew in hills showing vigor of plant and a goodly production of large, nice market tubers other than the one or more sec-

ond-size which the hill may contain. The practice of hill-selections of seed should be done, at least, every two or three years by the Northern grower, and every year will give better results. This involves some extra labor, but not so much as the average grower would think, and it is worth many times its cost.

The process is simple, and more uniformity of selection can be had by confining one's self to the one-stalk hills in the field; this can be varied, however, setting a standard for hills in about the ratio of not less than four nice potatoes large enough for market purposes to each hill of one stalk, and not less than seven, to each hill of two stalks, and ten, to a three-stalk hill, all grown from a single seed price. When the field to be selected from is from one-half to two-thirds ripened off, the grower, taking a bundle of twigs or sticks, goes over the field, up one row and down the next, and wherever there is a hill showing more vigor than the rest, marks it by placing one of the twigs, designating in this manner hills enough to furnish seed for the next season's planting. A little later when the field is ripe and ready for digging, it should be gone over with a hand-digging potato fork, and these marked hills dug out by this hand method. We know that all these marked hills have vigor that was apparent to anyone at the time the hills were marked, but what the grower did not know at that time, was whether or not they had desirability of tubers. It is not every vigorous hill that has tubers desirable for seed, either in number of tubers per hill or quality. Any marked hill that produces less tubers per stalk than we have set for our standard, should be discarded; also any that varies in type from she original stock, or for any other reason, such as roughness or prongs. In making a selection in this manner, we have got the following points: First, vigor, which is of prime importance, enabling the crop to be grown to withstand insects and blights without injury, when the weak stock, mixed in, which we have discarded by this selection, would be attacked by fungus diseases. This would spread to the more vigorous plants by being in such close proximity, and our whole field would die before it had grown a paying crop of tubers. Thousands of farmers have lost their potato fields at various times by having only a few weak, spindling hills there, which made breeding places for fungus diseases which would never have got started but for these weak hills.

Second, the grower is getting all of his seed stock from

hills that have produced a good number of market-size tubers which greatly increase the yield. Third, it has enabled him to eliminate any desire to sport which is rampant in even some of our best varieties, and keeps any variety in which seed is being selected in this manner true to name, and puts a stop to so much of the seed stock sold to the Southern potato grower becoming badly mixed, which is one of the banes of some Northern grown seed. The seed grower making a selection of this kind for his own planting, his resultant crop is sure to give satisfaction to the purchaser who buys it to plant, and is worth much more to that purchaser. In my own experience I have had a single selection made in the above manner increase the yield the following year over one hundred bushels per acre over the same variety taken from the same field, but sorted out of the bin the following spring when desired for planting. This method of seed selection is as applicable to the farmers of other states as it is to the seed growers and farmers of Maine. In many cases this would do away with any need of sending North for seed stock, and the yield per acre would be doubled in a few years without any additional expense in growing the crop. In a section where it is not necessary to get new seed every year, one wishing to get a new variety or new stock of an old variety to grow seed to plant and not being able to buy seed grown from selected hills, should buy large size potatoes of the variety wanted that are smooth and free from disease. My rule is, where possible, not to take anything under a pound each of the medium late or main crop varieties. By so doing I am sure that the seed I get has vigor, for not little, weak, sickly hill or stalk ever produced a tuber to weigh a pound. Planting these, hill selection can be made from those hills producing the most tubers per hill in number and weight, and the purchaser has got new seed containing both vigor and productiveness at a minimum cost. In selecting seed stock on the above plan, the size of tubers would need to be governed somewhat by the variety; for instance, with the Green Mountain or Norcross, a potato weighing a pound, is not an overgrown one, as in favorable conditions either variety will produce tubers smooth and nice weighing up to two and two and one-half pounds, and a tuber weighing a pound may be only one of a half-dozen grown on a single vigorous stalk, while on a variety like the Irish Cobbler potatoes weighing from one-half to three-quarters of a pound would indicate

vigor, and would be all right to plant to make a hill selection from.

Photo No. 6. A plate of Clyde Potatoes. One of the best medium late potatoes grown in Maine today. Originated in 1902 by the Johnson Seed Potato Co.

VARIETIES

It is quite an important matter that the grower obtains a variety which will do well in his particular locality. It is a common occurrence to see two varieties planted on the same field, both receiving the same treatment and planted on the same day, one giving double the market tubers of the other, and the tubers of both being of the same general appearance, so much so that the ordinary grower would be unable to tell them apart. One would spell financial success and the other ruin. In those sections where the potato can be raised year after year without changing seed, the farmer has a chance to test out new varieties and seldom meets with heavy loss. Where new seed has to be bought every year for a large acreage and proves to be an inferior variety for that section, the loss is heavy. Again, a grower has got to conform to shape and color demanded by the market he sells in to get the most out of his crop. As a rule, the most of the large markets are demanding a round white

potato with a shallow eye, and many of these are of fine quality. Some of the best eating, largest yielding and blight-resisting varieties I know of, will not sell well in the City markets simply because the public judges them by color; but to the grower who largely retails his crop to his own customers, they are of value, as his crop, differing in color and perhaps shape, from the majority sold in his market, gives him an added individuality and helps him to build up and keep a fine local retail trade.

There are many varieties which will not properly mature if planted as late as June 1st and will skin badly when dug, and never get to market in shape to get the market price for good stock. There are but few of these grown in Maine, but this cannot be said of New York and Michigan, especially the latter, where a large proportion of the potatoes grown are of this type. Michigan would be the banner potato state in the Union today, if she had not got into the way of raising Rurals and other varieties of this class, which has killed her prestige in the potato markets. The time was not so many years ago when Michigan largely governed the price in New York City, but that was before her farmers took to raising Rurals. Today Michigan potatoes sell about 15c per bushel less in New York City than does Maine stock. Yet Maine has much to learn along this line, she has no cause to cast reflections towards Michigan, the well graded ripened stock from Long Island brings from 50c to 75c per bbl. more than the Maine tubers. I firmly believe much of the soil of Michigan to be capable of producing as fine potatoes as Long Island and to command as high a price, but that will never come to pass with the varieties generally planted in that state at the present time.

For one to lay down a list of varieties for any section to plant would be folly, this I shall not do, but will name a few only of the newer varieties which have proved good from Maine to Minnesota. In doing this I shall not name any of the older ones except perhaps the "Norcross." **There are but few varieties of potatoes that do not begin to fail after their fifteenth year. For this reason it would be useless for me to name a potato for a section like Michigan, where it will take from five to eight years to get them generally disseminated, which has reached the age of fifteen years from the seed boll. To do so is to see the variety run out by the time it becomes generally known. Thus I shall name but three of the Medium late varieties, but varieties**

which will ripen up good and hard when planted as late as June 1st to 15th, and which are as fine table tubers as can be grown. These are the Clyde, Green Mountain Jr. and Snow. See photos Nos. 6 and 7. The Clyde and Green Mountain Jr. are only seven and ten years from the seed boll, and the Green Mountain Jr. should not be confounded with the old Green Mountain. The Snow is older, its age I am not sure of, but would place it around twelve years. These three potatoes will suit most any section, the Snow for light and sandy soils or light clay loam, the Clyde for heavy and clay soils, while the Green Mountain Jr. will do well on either if not too heavy clay or too light sand. These are three distinct varieties, yet they are so near alike in looks and eating qualities that no one can tell them apart in the market. Here in these three varieties we have one that will suit the farmer who has light soil, as well as the farmer with heavy, and which will suit the buyer and the market, for no one can tell them apart except the expert. I might go on and name several more which are good, but no better than these, but to do so would only tend to confuse, and help no one. What any section needs which has a diversity of soils are varieties which will do well on each, but which, when it comes to marketing will be alike as to shape, size, color and eating qualities, all of which are found in the above three.

I shall say nothing about the Rurals or potatoes of that class, they have their place, but they should at least be planted early enough to get ripe before digging and near enough together to prevent being overgrown. Much of this unripe, overgrown stock is hardly fit to eat and is never a source of pride to the grower.

As to early varieties the country today lacks a first class early potato. I shall mention but three or four and these with considerable mental reservation. The Irish Cobbler is perhaps the most generally known in the East. It is roundish white and a good yielder in many localities, while perhaps but a few miles away its yield is very light. The eyes are apt to be deep and the stem end is sunken and its quality is not first class in many sections. The chief reason it is grown in the North is to furnish seed for the early Southern crop, and the same can be said of the Red Bliss. Both of these potatoes have got to an age where they have done their best, but will be grown for some years yet for want of something better. The early Ohio is perhaps the

leading potato of the Central West. It is a better all-around potato than either the Cobbler or Bliss, it is reddish in color and when it grows well is of fine shape and good quality. I will mention but one more of the Early sorts, and this is the Early White Albino. It is the least known of either I have mentioned, but ahead of them all as to quality and yield. Its color is white and of as good shape as the Early Ohio. See photo No. 8.

Photo No. 7. Showing two hills of the Green Mountain Jr. potatoes. A large strong yielder originated 1905 by the Johnson Seed Potato Co.

SAVING POTATO BOLL SEED

There seems to be a lack of knowledge among many as to the proper way to save the seed from the potato boll. From letters received by the author, it would seem that many who are so fortunate as to find seed bolls on their potato vines have difficulty in keeping the seed through the winter, and I am led to believe that they have tried to keep

the seed over in the potato boll itself. This is all wrong, and I do not believe it can be done in a satisfactory manner by the majority of those who try it.

The seeds of the potato boll should be saved in the same manner as are the seed from the tomato.

Take a small vessel and cut open the bolls and squeeze the seeds into it, getting as little of the pulp as possible. The vessel should not be filled more than half full of seeds and pulp, but warm water should be added and the vessel containing the seeds set in a warm place for 36 to 48 hours until the mess ferments so that the little seeds will wash clear from the pulp. Care will be necessary in doing this work or the seeds will be lost. After being well washed they should be dried. This leaves them clean and dry, each seed a free atom. There are about nine hundred thousand of the seeds in a pound. When planting some very fine rich soil should be taken. Old rotted cow manure four or five years old, well screened is good, as it will hold moisture better than common soil. The seeds should be planted the last of March either in a hot house, cold frame or even in a box in the kitchen window, and should be covered very slightly with the soil. This should be kept damp by frequent watering or by a piece of woolen cloth spread over the box until the seeds begin to break ground. With me they come up about as quickly as weed seeds and it is rare that any fail to germinate. They can be transplanted like tomatoes, and will in many cases give tubers the first year that will weigh a pound or over. This is contrary to the common belief, but I have had a single little plant transplanted June 15th which yielded twenty-three market sized tubers with a total yield in weight of four and three-fourths pounds.

ORIGINATING NEW VARIETIES

Most new varieties are obtained from planting the true seed of the potato, which is found in the potato boll, the product of the blossom of the plant. These are as full of little seeds as are tomatoes, and there may be from a few dozen to several hundred seeds in each boll. Each separate seed produces a different variety. There is much more liability of the originators getting some new variety of value, if care has been exercised in growing the boll from which the seed has been obtained. Some varieties which grow

coarse, ill-shapen tubers, of very poor eating quality, seem to throw nearly, if not all their vitality into producing seed bolls. The varieties obtained from seed from bolls of this pedigree are most sure to be nearly, if not all, of the same

Photo No. 8. A plate of early White Albinos. A better early potato it would be hard to find, both as to quality and yield.

general characteristics as their parent. Probably not one in thousands will ever be of any value to the general potato grower. One wishing to originate new varieties should take one of our best standard varieties, and by a proper system of culture and protection from insects and blight, so build up its vitality that it will produce potato bolls. This is easily done in the Northern states, but might be impossible farther South. One wishing to carry on this work South of where our best varieties can be made to produce seed, should get seed from these best varieties, which are grown in the North, rather than waste their time with seed from those varieties which produce tubers of practically no market value.

Personally, I prefer to take seed bolls from a field containing only one variety. This should be of large yielding capacity, combined with very high eating quality, with no other variety planted near them. Seed taken from such a source will produce a greatly increased per cent. of valuable varieties.

The originating of the new varieties is of vital impor-

tance to the potato industry of the country, and the man who brings out a new seedling, which is a decided improvement over the older standard sorts, is entitled to a great deal of praise and financial return. The originator has his own troubles; a new seedling may give promise of being a great acquisition and make good from the beginning, up to four or five years old, and then go down in a single year, proving worthless. If a new seedling proves good for seven or eight years, and increases in productivity and quality each year, the originator can feel reasonably certain that he has something of value. The only proper way to test a new seedling is in general field culture, side by side with the best standard variety to be had. The seedling to be tested should be at least two years old, and four or five would give a truer idea of their worth. If they give larger yields then the standard variety, and quality and other characteristics are equal or superior, and give this result for two or more years, the originator is reasonably safe in pushing its sale. To the farmer, however, I would give this word of warning—don't invest a large sum in any new seedling until it has been tested out on your own farm in a small way; a variety that will do well in one section may not in another. Every large potato grower should test the newer productions. There will be so many of them that he will have to cast aside that no large sum should be invested in any one, until it has been tried and proven.

WHOLE POTATOES FOR SEED

The question of planting small to medium size potatoes whole, probably has occurred to every grower. It is one that should be thoroughly understood and the source from which the seed came be known in every case before it is planted. Failure to do this is likely to result in a loss in the yield of the crop. The size of the tuber and the time, and condition it is in when planted, has much to do with the results obtained. In testing out the value of small-sized whole potatoes for seed, I have planted a good many hundred bushels of them, and under certain conditions, there is no seed we can plant that will give us the results in yield and desirability that can be obtained from medium-size potatoes planted whole.

Small tubers that are to be planted whole should come from good, vigorous hills; this is of the first im-

portance. They can be selected from a bin, provided these were grown from selected seed and the whole field was vigorous and thrifty. If there were many spindling stalks or weak hills in the field, the small-size potatoes should never be planted that grew on it. A good, vigorous hill seldom produces more than one or two tubers, small enough to plant whole, and many times there will not be one in several hills small enough for this purpose. The weak, spindling stalks and hills, not having vigor enough to produce large tubers, will nearly all be of the size needed for planting whole. Thus it will be seen, unless care is used in getting seed of this kind, we will be planting tubers largely from the weakest hills in the previous crop; and as "like begets like," our crop is sure to suffer. The best size of tuber to use I have found to be just about as large as a medium hen's egg, and with rows three feet apart and seed dropped fourteen inches apart in the row of a size will take about twenty bushels per acre.

If a potato of this size is planted when in a dormant condition or before the sprouts have started, there will usually be from one to three sprouts start from the seed end. These start so much quicker and stronger than those from eyes nearer the stem end, that they will use up the plant food contained in the tuber, and there will be no sprouts start from the other eyes. If tubers of too large size are used, the quick starting sprouts on the seed end will not use up all the plant food they contain and there will be many weak sprouts start from the other eyes. These would not amount to anything as tuber-producers, and to all intents and purposes are simply as so many weeds. It is not best to plant tubers of too small size, even though they come from good, vigorous hills, neither is it best to plant any potatoes whole after the eyes have once started, as there are most sure to be too many stalks in a hill. This can be varied in case of very early potatoes where the side sprouts are broken off by hand, leaving only one or two of the best on the seed end. The advantages of planting whole seed when they come from thrifty, vigorous hills are that they are certain to produce a perfect stand of plants, no matter how the weather may turn after planting. The vines grow faster and the crop will mature from one to two weeks ahead of cut-seed planted at the same time and under the same conditions. The resultant crop will be smoother and rounder potatoes than usually

grow from cut seed. Why this is so I have never been able to determine. In planting whole seed, if desired, more fertilizer can be used in the drill at time of planting, without injury to the seed, as there is no cut surface for it to come into contact with. There is also less injury to the seed by wire worms when planted whole, if they are present in the soil, than is the case of seed cut.

GREENING AND BUDDING SEED POTATOES

In planting potatoes for early market, time can be gained by budding or sprouting them. This is especially true for the small grower, who can spend the time necessary to do this work just right. Many times the owner of a small garden wishes to grow a few early potatoes for his own table, and anything that can be done to hasten early maturity is of value to him. While potatoes can be sprouted or started for later planting, with a potato planter, the buds or sprouts should not be allowed to get growth enough so that they will be broken off in the machine. This is the most sure to be the case if the buds are allowed to get much of a growth. No potatoes which are to be planted in a planter should be allowed to start their sprouts to the extent that they will be broken off by the machine when planting. This results in a loss of vitality, as a portion of the plant food stored up in the seed piece has been used up. The second starting of the bud will be weaker than the first, and cannot, all other things being equal, produce as many tubers as will the first budding of the sprout. In starting the sprouts for early hand-planting, the potatoes should be brought into the light and air, where it is reasonably warm. The stronger the light, the shorter and greener the sprouts. For very early planting, it is better to have the sprouts started in semi-darkness, so that they will be a reddich pink in color and thick and stocky. Such sprouts will push up through the soil quicker than will the short, dark, green sprouts started in bright sunlight.

Potatoes sprouted in this manner ought to be planted when the sprouts are just right, as delay of even a few days will allow them to get so far long that it will be almost impossible to cut and plant them, even by the most careful man, without breaking them off. Those who are intending to plant only a bushed or two in their kitchen garden, and desire to get them as early as possible, the seed can be put

into boxes, which should not be over five or six inches deep, and placed in a light, warm place where the heat is not too great, and sprouted there. Those who are to plant a larger area, an available barn floor will do, provided light and warmth enough can be obtained; or they can be spread out of doors in a dry, warm, sunny place. In the later case care must be taken to fully protect them from the cold nights, as long as there is any danger of their freezing. As very early potatoes are planted usually before the late frosts are over, and as they would need to be sprouted from one to two weeks before planting, the danger of sprouting out of doors so early in the season is quite considerable. But for the late or main crop there is no better way than spreading them right out upon the ground. A place should be selected, if possible, where there is a good turf and still not but little grass. If there is no turf the sprouts on the under side of the tubers will take root into the soil, which very materially injures them for planting. On the other hand, if there is too much grass to grow up around them, the same thing will happen. Partial shade is better at first, if the tubers are right from the cellar and hard and cold, but if they have been exposed to light in the cellar for a week or two it is all right to spread them right out in the sun when first taken from the cellar. The point is, that too great a change from a cold, dark cellar, where the tubers are hard and cold, to direct rays of the sun, is not the best plan. Potatoes handled in this manner will sprout and grow all right, but the change is too severe for the very best results, and if it is necessary to take them right from the cellar to a place selected to spread them where they will get the direct sunlight all day, it is far better to leave them in bags there for a few days, turning the bags over once or twice in order that all the tubers may green and soften somewhat before spreading them out. They should not be spread over one deep on the grass, and it is better if they are to lay there several weeks to rake them over at least once a week. This will expose the whole surface of the tuber to the direct rays of the sun. It is claimed by many that the sun's rays will kill the scab fungus, and my experience is that it is at least beneficial in this respect. I have seen many acres of potatoes showing missed hills, from ten to fifty per cent, or even more, which was wholly the result of neglect or want of care or knowledge in handling the seed before planting. The loss from a poor stand of plants to the potato growers

of this country every year is enormous, and when we consider that a large part of this can be overcome by a little care in handling the seed before planting, it becomes of very great importance, not only to the grower, but the consumer as well.

To begin with potatoes intended for seed should be stored in a dark, damp cellar, and kept as cool as possible without any danger of freezing. If they can be kept perfectly dormant up to the time they are needed, with the tubers dry, hard and cold, we have them in the best possible condition to make a start for a good crop. With potatoes in this condition, some two or three weeks before we are to plant them, they should be taken from the cellar, put into sacks, a bushel in a sack, and soaked for two hours in a solution of formaldehyde. (See chapter Treatment for Scab.) When the bags are removed from the solution they can be placed upon the ground, where the potatoes are to be spread and let remain there some four or five days, turning them over once or twice during this time so that all may soften and green alike. Then spread them out only one deep on the turf. If they are raked over about once a week, so that the sprouts on the under side won't send roots into the soil, they will keep in almost perfect condition for planting all summer. I have had them keep in perfect condition, treated in this manner, spread in the direct sunlight, until spoiled by the frosts of October. Seed treated in this manner will give a perfect stand of plants unless insects or mice destroy the seed after planting.

Now if the grower finds his seed tubers starting badly in the cellar long before it is safe to spread them out of doors, the same process as I have described can be followed by spreading under cover where there is light.

SELECTING AND CUTTING SEED

Having selected a variety that will thrive in his locality, the grower must select seed free of scab. Good, smooth tubers, of an average size, will cut up into more uniform pieces, which is a saving of trouble, if to be used in any of the planters. It is really of more importance to the farmer, who is using a planter, that his seed be cut to a uniform size, than that there should be a certain number of eyes on each piece. Hand-cutting by one, who knows his business, is to be preferred to any of the potato-cutting

machines, which mangle more or less and cause an uneven stand. In hand-cutting, the knife should be ground very thin, not much thicker than common writing paper, or just as thin as it can be and stand the work of cutting. This will allow the user to cut many more bushels in a day's time, as he will feel hardly any resistance as the knife passes through the tuber, and the cut pieces will not be mangled. In cutting potatoes large enough to make over four pieces, it is better to first cut the tuber in half, as shown in the center of photo No. 9 and if very large, into quarters. Either the center or right hand tuber, shown in the cut, should be quartered. In all three of the potatoes shown in the cut the stem end is down. In cutting up either into halves or quarters, cut above the eye. The eyes of a potato have roots always running towards the stem end of the tuber. These take the stored-up plant-food, which the tuber contains, to the sprout. If these are cut off close to the eye, while there

Photo No. 9. Showing method of cutting seed tubers, the stem end being down.

might be a good-sized piece of the tuber above the eye or towards the seed end, the sprouts would have no way of getting the plant-food it might contain, as it has no eye roots running towards that end of the tuber. In this case it would not make so strong or thrifty a plant or yield the tubers it otherwise would.

The potato on the left, shown in the cut, is a medium-sized tuber, or what would be termed a good second. As the reader will note, the stem end is cut off, cutting above at least one good eye and taking about one-third of the tuber. This usually allows from one to three or more good eyes on this stem end third of the tuber, even in a variety possessing but few eyes. The next cut is made by cutting from the upper or seed end down towards the stem end. This makes three pieces of a tuber of this size, and there will always be plenty of eyes on each, and very evenly divided between the three pieces. It also has the advantage of having them of very uniform size, which insures much better work with any of the planters. As it is no more work to cut potatoes with this idea in view of cutting above the eye, and the potatoes will come up a little more vigorous, it is well to observe it. With potatoes the size of the one on the left, cut as that one is, it will take about twelve bushels of seed per acre, with rows three feet apart, and dropped fourteen inches apart in rows. **Cut seed should never be left in bags or piles so that there is any danger of its heating. Seed that has heated even a very little is unfit to plant, and if it comes up at all it is weak and spindling and beyond any possibility of making a paying crop. The proper way to treat cut seed is to sprinkle liberally with land plaster (gypsum), as fast as it is cut, being sure to get all the cut surface covered with plaster. This keeps them cool and prevents dying out, and if spread out, not over six inches deep until wanted to plant, will not hurt, even if cut a week or ten days before planting, provided they are kept in a cool, shady place.** Sulphur is also good for dusting the seed pieces as they are cut. In fact I have used the latter almost entirely these last few years, especially on land where wire worms were known to be present. Sulphur is not a sure deterent for preventing the wire worms from getting into the newly planted seed, but where care has been used to get all the cut surface well covered with the sulphur, I am sure that it prevents damage by this worm to quite an extent.

If fertilizer is used, the land plaster or sulphur will also prevent it from coming in contact with the cut surface of the seed, which otherwise it might do, causing decay to begin before the sprout starts, and many times the seed altogether. This is more likely to take place when seed is planted as fast as cut, and experience shows that the best results come from seed cut from twenty-four to forty-eight hours before planting, and liberally sprinkled with the land plaster or sulphur at the time of cutting. It will pay any grower to follow along this line as far as possible.

The size of the cut pieces has much to do with the vigor of the sprout, and a fairly liberal piece should be allowed, especially if the weather is cold and wet at planting. With rows three feet apart and pieces dropped fourteen inches apart in the row, twelve bushels of seed per acre is none too much, but if the weather is warm and the soil warm and moist, the seed can be cut finer, say to ten bushels per acre, and a good, vigorous stand result.

A great many growers practice clipping the tip off the seed end of the tuber. There is nothing to be gained by this; in fact, in many cases, it is a distinct loss. Of all eyes on the tuber, the one or two directly on the seed end are the earliest and most vigorous, and the clipping of these deprives the grower of the strongest and best eyes on the whole potato. This may not possibly be true of some varieties, but it certainly is of the greater number. The general feeling of those who practice this is that there will be so many stalks come from the cluster of eyes at the seed end that there will be too many potatoes set to grow to good market size. This is not true of potatoes planted in a dormant condition, as one or two, usually one eye on the seed or tip end, will start so much quicker and stronger that all the plant food in the potato, if small or from reasonable sized pieces will be taken, the other eyes failing to make any growth.

One of the reasons why the Author prefers the hand over machine-cut seed is that it enables the one cutting to keep a much better oversight over the tubers cut. This allows him to throw out many which would not be noticed by one running a cutter. There are so many diseases of the potato which are spreading over the country, some of them very bad, like "Stem Rot" and "Late Blight," that no tuber which shows any sign of disease

should be planted by anyone. The soaking of the seed tubers in the formalin solution will kill the spores of most of these diseases which are on the surface of the tubers. It is a much more serious matter when one has the "Stem Rot" or "Late Blight" fungus to contend with, as the spores of these are inside of the tuber itself and cannot be killed by soaking the seed. Therefore, any tuber, when cut, which shows any discoloration which may be either of these diseases, should be thrown away and the knife disinfected before another tuber is cut. The writer keeps a pint glass jar filled with a strong solution of formalin, and dips his knife into it whenever he cuts into a tuber which shows any discoloration from any cause. Such discoloration might be harmless, and again with purchased seed, it might contain the spores of one or more of the worst diseases a potato grower has to contend with, and by using the knife without disinfecting it, would carry these spores to several other tubers. It is better to have two knives for each one cutting, and when a potato is cut into which shows signs of any disease, the blade can be placed in the formalin solution and the other knife be used until another bad seed tuber is cut into, when that knife can be placed in the solution and the first knife be used again. My own opinion is that it is better to do this every few minutes, even if the operator has seen no signs of diseased tubers. The cost of enough of the formalin solution and the time taken to change knives is so small as not to be even reckoned with, and it will make many hundred hills difference on each acre planted, if there is by any chance a few tubers with the stem rot or late blight in the seed potatoes. **As the formaldehyde solution loses its strength very rapidly when exposed to air, the writer uses a glass preserving jar to hold the strong solution necessary to disinfect the knives. Keep the jar covered at all times when not actually cutting the seed tubers. When the cutting stops, even for the dinner hour, the cover is put on the jar, having the rubber underneath which makes the jar air tight. If care is used to keep the jar covered at all times when not actually cutting potatoes, one mixture of the solution will do for several days' cutting of seed.**

PLANTING EARLY POTATOES IN A GARDEN

In treating on the planting, I shall take it up under

three divisions: First, taking up planting of the very early varieties in a small way. Those who are growing a few for their own table, and desire to get them very early, can take more pains in planting them than can the larger grower.

The gain of a few days in the maturing of the crop more than pays for the extra time and trouble necessary to obtain this result. A warm, sunny slope to the south, or better still, to the southeast, on land as little subject to late frosts as can be selected, will, of course, be the best. It should be well fitted by deep plowing as soon as frost is out so the work can be done. Frequent workings with the harrow, both to fine and lighten the soil, and also to warm it, will, if it can be so arranged to have this work done without too much cost, help gain a few extra days in maturing the crop, and in this way prove profitable. If these harrowings can be done just after the heat of the day, turning under the top or warm soil and bringing up the colder soil underneath, and followed for a few days, if the weather is warm, will increase the warmth in the soil to quite an extent. A few extra degrees of heat in the soil early, means a great deal to the grower of early potatoes. When the soil is well fitted, furrows should be opened quite deeply, and for these early varieties, a distance of from twenty-six to thirty-four inches between furrows is room enough. For extra early potatoes, there is nothing that will force a quick growth any better than fine hen manure, it being rich in nitrogen. If the potatoes are liberally sprinkled with land plaster when cut, and sulphur scattered along the rows at planting, usually but little damage will result from scab from this use of hen dressing, where potatoes are to be dug early. Later on, when the potatoes have well started, some fertilizer containing an abundance of phosphoric acid and potash to force tuber formation and growth should be used. If hen manure is used, it should be drilled along the furrow and mixed into the soil, so the seed pieces when dropped will not come in direct contact with it. The same rule would also apply to commercial fertilizer; if circumstances make it necessary to use barn or stable manure, it will do no harm to the seed to drop it right upon the dressing.

The objection to this is in the labor involved to drill the manure, and the ever-present danger of scab. Rot need be but little feared on very early potatoes. The seed pieces should be dropped about fifteen inches apart in the row, some taking the time and trouble to place these with the

sprouts up. This is a needless waste of time and labor. I have carefully tested this, and if there is any difference in time of coming up, it is in favor of those pieces dropped with the sprouts down. The first covering of this seed, while it will depend somewhat on the nature of the soil, should be light, not over one and one-half inches in the heavier soils, and two and two and one-half inches in the lighter, and the rows should be deep enough so that after the seed is covered, there still should be a depression of some two or three inches. If the seed has been well sprouted and carefully planted, it will begin to break ground in from one to two weeks, according to weather conditions. The depression along the rows can be gradually filled in as the plants grow. The weeder can be used, if run lightly, but care should be taken not to break off any sprouts from these early potatoes, as the time taken for the weakened seed pieces to throw another sprout will make it so late, that that hill will be worthless when the others are ready to dig, and for all practical purposes might just as well have been entirely destroyed. If at any time there is danger of frosts after the potatoes break ground, they should be buried up with soil; this can be done very quickly with a horse hoe, and if there is a depression along the row, they can be buried up quite deeply without making too much of a ridge, and as soon as the danger of the frost is over, the weeder can be again used to smooth the field off level, killing out all weeds which have started. This will put the field in condition to be again buried if another frost threatens. Previous to the second burying, an application of fertilizer should be scattered along the rows, and the second burying should cover this fertilizer at least three inches. If this fertilizer contains quite a per cent of nitrogen in the form of nitrate of soda, it will give the plants a very quick start, as they have at this period a well-developed root system. This nitrogen would not be so much needed in case of potatoes planted on hen manure, but a fertilizer containing a high per cent of phosphoric acid and potash applied in the same manner would be highly beneficial in this case.

The point in getting potatoes early, is to get them up as soon as possible in order that they can develop root growth, and still keep the tops small enough so that they can be covered with soil at any time to protect them from late frosts. In this manner, with a well-developed root system and the second application of fertilizer applied at

just the right time, the grower can produce a crop that will catch the high prices of the early market. As the reader will see, this method could not be used in large fields where it is necessary to use a planter, but in a small way it has advantages. Well-sprouted seed, planted and covered lightly at first, practically insures a perfect stand of plants. This, many times, will largely make up for the extra cost of the labor involved.

Another point for the kitchen garden grower, is to take medium potatoes of about the size of a large hen's egg and sprout them as above described. At planting, break off all sprouts but one or two of the best and strongest at the seed end of the tuber. In this way there will not be one chance in a hundred of the seed rotting in the ground, no matter how cold and wet the weather may turn. Of all eyes on a potato, those on the seed end are the earliest and strongest, and by breaking off all but one or two of these we have the very earliest and strongest eyes on the whole potato.

These having such a start will take out so much of the plant food contained in the tuber that there will seldom be enough left to start any more stalks. Whole potatoes, of the size above described, taken from the cellar in a dormant condition or before the eyes have started in the least, and planted whole, will seldom produce, on an average, more than four stalks to each tuber planted. This is too many for very early varieties, as the resulting crop would be too many in number and of too small size. By breaking off all but two or three, or if large-sized tubers were wanted very early, all but one, it would mean but one strong, vigorous stalk in a hill which would produce the result wanted.

If the grower will take two bushels of medium tubers, about hen's egg size, from the cellar when they are in a dormant condition, cutting one bushel of them either in halves, thirds or quarters, as best suits him, and plant the other bushel whole, side by side with these cut ones on the same day, under the same treatment, he will find those planted whole will mature or ripen from a week to ten days ahead of those cut. The cutting of the tubers seems to delay its maturing its crop. If we take a tuber of the size of a hen's egg and sprout it as we must to get a very early start of our crop and plant it whole, all the eyes which have gotten well started will produce a stalk, re-

sulting in too many stalks in a place, and to get both results tending to the earliness of our crop from both sprouting and planting whole seed, we are obliged to break off all but one or two of the strongest sprouts on sprouted medium-sized potatoes and then planting them whole. This is too much labor, except in a small way, for the small grower.

FIELD PLANTING OF EARLY POTATOES

In planting early potatoes where the acreage is large enough to make it necessary that the work should be done with the planter, the sprouts cannot be allowed to start as much as with the carefully hand-planted tuber. Still, if the crop is desired early, quite a little time can be gained by starting the sprouts in a warm, light place. The long white sprouts which start in the cellar are of no use; they only sap the vitality of the tuber, and cause the next set of sprouts to be weaker, and they will not produce the crop of potatoes the first would. The seed should be kept in a cold, dark place where the temperature is about thirty-five degrees, to get the best results. A few weeks previous to planting, they should be brought into a warm, light place and spread where the sprouts will start. I do not prefer for the sun to shine directly upon potatoes put to sprout, for the very early crop to be planted in a small way by hand, as described under that head, but it is all right for those which are to be planted through a machine, the sun will green and toughen the sprouts, and at the same time soften up the tubers. Potatoes exposed to direct sunlight will start their sprouts more slowly and they will be stouter and less liable to break off. In other words, direct sunlight will seem to put the potato in better shape to start its sprouts quickly when planted in suitable soil, and at the same time start them the least before planting. As it won't do for seed, which is run through a planter, to have the sprouts but just well started, owing to their breaking off, this is a decided advantage.

Potatoes warmed and softened by the sun, with the sprouts just well showing in the eyes, will come forward and be from one to two weeks ahead of the same seed taken from the cellar or pit, and when cutting, this gives a chance to throw away all impotent eyes and all tubers

in which the sprouts fail to start. This insures a much better stand of plants. The ground should be well fitted in order that the planter can do its best work. The depth to plant early potatoes with a machine must, to a certain extent, be governed by local conditions. In sections where there is but little danger of moisture becoming short early in the season, they can be planted more shallow. The deeper they are covered the longer they will be in coming up, and in many cases the weaker they will be. If the crop was desired as early as possible, I should not have them covered over two inches below the surface of the ground when the ridges which the machine left in planting is leveled off. This leveling off should be done as soon as possible after planting. In order to be sure that all seed is covered on an average of two inches after the surface has been smoothed down, the planter must be set so that there will be at least five inches of soil over the greater part of it as the planter leaves the rows before leveling. This extra three inches should be worked off at once, as it prevents both air, light and warmth from penetrating to the planted seed, and delays growth and would retard the crop many days. The top soil is the warmest in the early spring, but we have got to keep in mind the fact that later in the season, the soil deeper down contains more moisture, and is in better condition for growth of tubers than is that nearer the surface. We must have even our early potatoes rooted as deeply as we can, and when we have planted them only two inches below the surface, we have made as great a sacrifice for warmth and an early start of the crop as the exigencies of the later part of the season will warrant.

In planting early varieties of potatoes, I have found it best not to use over seven or eight hundred pounds of high-grade fertilizer per acre, in the drill, at planting time. Early varieties are not so vigorous, as a rule, as the later or main crop, and the amount of fertilizer that many times will not cause any appreciable damage to the later kinds will do quite an amount of damage to the seed of an early variety. The rows of an early variety, with its usually smaller growth of vine, can be several inches nearer together, most growers planting from twenty-six to thirty inches.

In planting early potatoes, it is better to have fertilizer of two different formulas. The one to be used in the

drill to have its nitrogen in a slower form than nitrate of soda, as it is usually several weeks before the plants would have root growth enough to readily use it. Nitrate of soda is available over night when placed in damp soil, and would be, in case of heavy rain previous to the potatoes breaking ground, largely lost to the crop. When plants are well up, so that the rows can be plainly seen, the balance of the fertilizer to be used should be applied. In my experience, I have got the best results from applying this along the rows and by hilling the plants, covering them some three or more inches.

This second application of fertilizer can have nearly half of its nitrogen content in the form of nitrate of soda. The plants will now have a large root system, and can use it, and it will cause them to make a very quick growth at this time. This is of much importance, as the quicker the ground can be covered with vines the less moisture is lost by evaporation, and the more rapid growth at this time the less real damage is done by insects, especially that scourge to early potatoes, the flea beetle. The quicker we can get our vine growth on early potatoes, the better, and I know of no way to so rapidly push it along as by an application of fertilizer along the rows, containing quite a part of its nitrogen in the form of nitrate of soda, after the plants have broken ground and have a well-developed root system.

PLANTING THE LATE OR MAIN CROP

In planting the late, or main crop, but little difference in the method is required over the machine-planted early crop. The seed should never be allowed to sprout in the cellar or pit, as these sprouts are of no use and result in a great loss of vitality. If it is possible when one finds his seed stock starting in the cellar before he can use it, it should be gotten out into the sunlight and spread out, not over one deep. Potatoes that have begun to sprout will keep in good condition to plant, spread out in the direct sunlight much better and longer than in any other way. If they have been kept in cold storage, at a temperature too low for sprouts to start, they will require considerable more time to break ground than if they are warmed up a short time before planting. The ideal way to treat any potatoes intended for seed is to keep them at such a temperature that the sprouts

will not start, and then a short time before needing them to plant to bring them into the light and sun. In the case of the late or main crop, to expose them to direct rays of the sun, spread out thinly just long enough to get the buds well started. They can be spread out of doors on the grass, but it is much better to have them under cover in a building with windows enough to let in plenty of sunlight, as then there is no danger of late frosts doing them damage. In cutting such potatoes, all weak eyed ones can be readily detected and thrown out, which would be impossible to do if cut right from the cellar or pit. Seed handled in this way has all its vitality to put into the sprouts which are to make our crop.

This one point in handling seed potatoes may make a difference between a good profit and a no inconsiderable loss. The method of cutting seed is described under that head. The planting of the late or main crop should be deeper than for the earlier planted. The reason for planting the general early crop more shallow is because the ground is cold, which is likely to cause a loss in the seed by rot and a delay in coming up if planted as deeply as the later varieties, which with an early crop is something to be avoided. With the main crop it is different, as the planting is later and the soil has had time to warm up, and, having been well prepared, the planter should be set to drop the seed at least three inches deep, even in the heavier clay loams, and four inches is better in most soils adapted to potato growing. About one-half of the fertilizer should be used in the drill at time of planting, or at least up to one-half ton of high-grade fertilizer per acre. I do not find it advisable to use more than this in the drill, even on the vigorous late varieties, unless medium-size whole potatoes are being planted. In this case as much as one ton of high-grade fertilizer per acre can be used in the drill without but little harm resulting to the seed, especially if the seed has been well started by exposure to the light and sun.

The main crop varieties, which, as a rule, are of much larger growth of vine, need to be planted in rows farther apart than the early kinds. The most of them in the State of Maine are given from thirty-two to thirty-six inches and about fourteen inches in the row. With some of our best late varieties I have been forced to plant as near as twelve inches in the row, in order to keep the size down to that which the market most demands. This might not be the case in many sections where dry weather is likely to cut the

size down more than it is along the coast of Maine.

STABLE MANURE

Stable manure is but little used in Maine in growing potatoes. It has a tendency to cause both scab and rot, and should only be used on land intended for potatoes, when such land is sadly lacking in vegetable matter.

As I have said previously, the potato demands a lot of humus in the soil to do its best, and only when it cannot be supplied in any other way is it advisable to cover the field with stable manure. This, of course, refers to applying manure directly preceding the planting of potatoes.

On the other hand, stable manure seems to add to or give more life to soil bacteria that are so essential to crop growth. Land that is well supplied with this soil bacteria to start with can and will produce great crops for years on commercial fertilizers, provided there is plowed under a goodly supply of the clovers, vetch or other humus-making material.

Even if this is done, there is but little doubt that a good application of stable manure once every few years will give new life to crop productions far in excess of the actual plant food it may contain.

The question with the potato grower is whether or not the application of stable manure will not cause a loss in quality as well as making the tubers rough and scaby to offset the gain of the few bushels extra yield per acre which usually results from its use. The proper time to apply it to land that comes in the potato rotation is after the potato crop is taken off. In this way, by the time potatoes are again planted in the field, there will be but little tendency left from its effect to produce either scab, rot or a loss in quality. When applied to the newly seeded clover after a potato crop, it will help greatly to make a vigorous perfect stand of clover. This insures a good sod to plow under to furnish vegetable matter for the next crop of tubers when the rotation comes around to potatoes again.

I have grown as good crop of tubers as I ever grew on barn dressing alone, free from scab and rot, and of good quality; but this is the exception, and the safer way for the potato grower who seeks fine quality in his

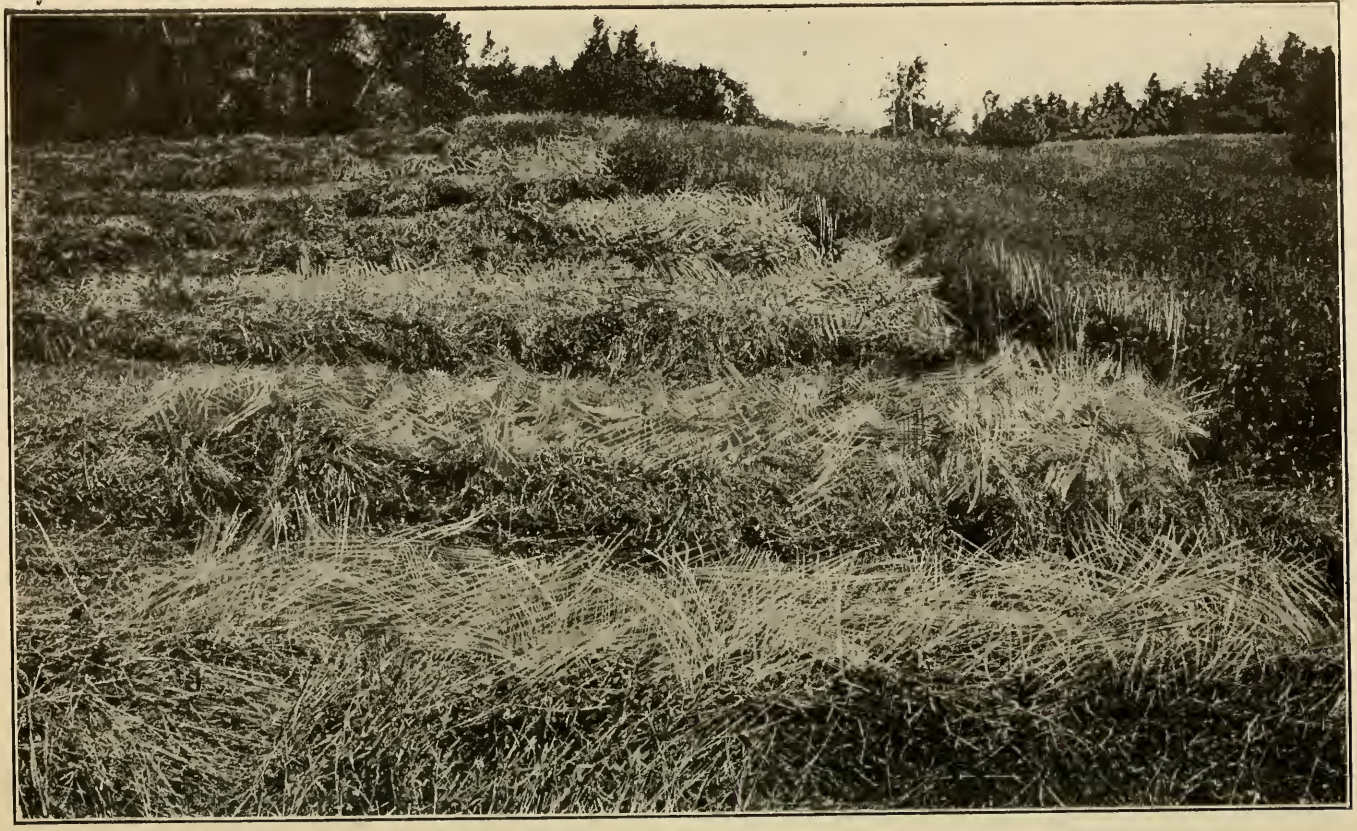

Photo No. 10 Showing the first year's hay following potatoes on the author's home farm. This field had not been plowed or fertilized for nearly 25 years previous to plowing for potatoes. A ton of fertilizer was used per acre for the potato crop, but none for the grain or hay. This brings one ton of fertilizer per acre on this

product is to use this valuable product of the farm in growing some crop other than the potato.

COMMERCIAL FERTILIZER

Probably there is no crop grown today, by the Northern farmers, at least, that will give so great a profit one year with another, when the plant food to grow it is bought in the form of commercial fertilizer, as will the potato. For this reason, more than any other, is the potato in the Eastern states grown on plant food purchased in the form of chemicals or commercial fertilizer. Probably ninety per cent. of the potatoes grown in the State of Maine have the plant food supplied to the soil in this form.

There has been a vast deal of discussion as to whether a farmer can maintain or increase the productivity of his farm by growing crops on commercial fertilizer alone, many claiming that it cannot be done, while others, taking no part in the discussion, have gone ahead year after year and demonstrated its entire practicability. Many of the first users of commercial fertilizer made the mistake of using a few hundred pounds per acre in the production of grain. This gave good results for a short time and then failed utterly, even with much heavier applications than at first. The reason for this was not generally understood at the time, and is not today in far too many cases.

Commercial fertilizer will not supply any of the bacteria to our soils which are absolutely necessary for a soil to be productive. More than this, it does not supply any vegetable matter to the soil, which is also absolutely necessary for what bacteria there are in the soil to live and thrive. There is, I believe, a ground for belief that heavy application of the strong potash salts (acidulated phosphate rock) and nitrate of soda tends to kill out the bacteria by direct contact with them in the soil. If heavy applications of these are made every year and no stable manure used, or leguminous crops turned under to bring a new supply of bacteria to the soil, it is only a question of a very few years when the soil, being deprived almost entirely of bacteria, will not produce a paying crop of anything, regardless of the amount of plant food it may contain. In addition to this loss of bacteria which the soil will sustain, it loses also in its mechanical condition, as well as in its water-holding capacity, becoming heavy, inclined to bake after rains and, instead of having a moist, lively look, is dry and dead looking.

The question then arises, Can the farmer, who is so situated that it is not advisable for him to keep stock, grow potatoes on commercial fertilizer year after year and maintain the productivity of his soil? There is no question but what he can (see photo No. 10); but if his soil is deficient in vegetable matter, and, in that case, of bacteria also, he has got a longer, harder road to travel before he gets it back to producing maximum crops. If it is well supplied with both humus and bacteria to start with, each year will see it producing more and better crops.

As practically all soils have a great deal of locked-up plant food in them, some an immense amount, no matter how run-out they seem to be, the increase in productivity comes largely from the acids formed by the decomposing vegetable matter breaking down and making this available for the growing of crops. That the bacteria aids in this decomposing of the vegetable matter and the forming of these acids, which break down and liberate this locked-up mineral plant food, there can be no question. That they directly take part in the process is open to doubt.

One of the chief objects of the potato grower who is using commercial fertilizer wholly in growing his crop is to get and maintain this vegetable matter in his soil, in order to get satisfactory results from the fertilizer applied. The amount to be used per acre should not be governed wholly by the amount he expects the potato crop he will raise will take off. For this reason, the most successful potato growers are applying many more pounds of phosphoric acid and potash than any crop of tubers they may raise can possibly remove.

There are certain sections where potash seems to be needed but little, even in growing potatoes, while phosphoric acid is needed in large quantities, although the potato crop itself needs but comparatively little phosphoric acid. These facts make it impossible for one to give any set rule as to the formula another should use in making up or selecting a fertilizer for his potato crop. This should be, however, selected or made up with due consideration as to what the crops which are to follow the potato in the rotation will need.

Probably a 4-6-10 formula is more largely used by the Maine potato growers than any other combination. I refer to this not as a guide for the grower in other states to follow, but to the fact that there is no section of the country where run-out, abandoned farms are now being brought up

to a state of productivity so rapidly as they are in Maine. This shows that this formula is not only giving the Maine farmer the largest yield of potatoes per acre of any state in the Union, but is adapted to his general rotation as well. That the phosphoric acid and potash can be varied to suit different sections and given even better results than the majority are now getting seems probable. But for a general formula a 4-6-10 will probably suit as many different soils as any, where the land is to be put into a rotation, including potatoes, and its productivity increased. However, a 4-6-10 fertilizer usually carried quite an amount of what is known as filler, which the purchaser has to pay freight on, as well as handle, and it is far better and cheaper to buy a 4-8-10 fertilizer, as there can be but very little in a fertilizer of this high analysis.

The amount of plant food removed from the soil in a crop of three hundred bushels of potatoes is, according to the best authorities, about 58 pounds of nitrogen, 27 pounds of phosphoric acid and 80 pounds of potash. As heat and cold, dry or wet weather affects the availability of the plant food in a fertilizer, we have to apply much more potash and phosphoric acid than a crop will take off, in order to have what the crop needs available at the time the crop most needs it, if a maximum yield is to be obtained.

The larger part of the best farmers not only in Maine, but in most other sections where potato growing on commercial fertilizer is made a business, use a ton per acre of a fertilizer of a 4-6-10 analysis. This means that they are applying 200 pounds of potash, 120 pounds of phosphoric acid and 66 pounds of actual nitrogen. With a crop of three hundred bushels per acre, there are left in the soil 120 pounds of potash, 93 pounds of phosphoric acid and 8 pounds of nitrogen. Nitrogen is the most elusive element we have in our fertilizer, and it is not economy to apply much more in any one season than the crop we expect to grow that season will use. The margin between what a crop of this size would take off in nitrogen and the amount we have applied in the ton of fertilizer is so narrow that if the crop depended altogether for its nitrogen on what we applied in this way, its growth would suffer. This would be especially true in dry seasons. As potatoes should always be planted on land containing more or less decaying organic matter, nitrification is going on, furnishing enough available nitrogen to make up all that the crop will need to do its best.

The office of nitrogen to the plant is to promote vine growth, and an abundance of this element causes a heavy, dark green growth of leaves and vines, and in case of a fertilizer not well balanced up with phosphoric acid and potash might, and in most cases will, produce much vine growth, with few and small tubers. If either element was to be lacking, it had better be nitrogen, especially towards the last of the season. On the other hand, plenty of available nitrogen early in the season, to promote vigorous growth of vines to cover the ground and prevent evaporation of moisture and check the germination of weed seed, usually results in a good crop. Potash and phosphoric acid promotes and develops the formation of tubers, which takes place later in the season, the tubers growing until the vines are entirely dead.

The vast importance of ready-mixed fertilizer to the potato growers of Maine, and the unquestionable fact that the farmers, especially the potato growers of the Central Western states, have got to begin their use in a very few years, makes the question of how and what to buy of great interest. The plowing under of clover and the use of barn dressing has been practically all the fertilization given the potato in many sections where they have been largely grown. This form of fertilization is unbalanced, for there is but little phosphoric acid and potash returned to the soil in the barn dressing, especially where the liquid part of it is allowed to drain away, as it is on so many farms.

There certainly will come a time when phosphoric acid and potash will have to be applied, or the growing of potatoes will become a failure. This failure will show fully as much in the quality of the crops grown as in the quantity, as the tubers will grow rough and scraggy in appearance and be more often afflicted with scab. This condition can be almost entirely overcome by good seed, a proper handling of the soil and the intelligent use of a properly made commercial fertilizer. I presume the knowledge the Maine potato growers have of commercial fertilizer has cost them millions of dollars, and it is pretty safe to say that any section just beginning their use will pay a like penalty. **In the first place, no farmer, if he needs a complete fertilizer and wants to get his money's worth, should buy a cheaper grade for any crop than a 4-8-10. It is also true that in a section just beginning to use commercial fertilizers that a grade as high as a 4-8-10 is scarcely sold at all or even heard of. Now, to make a**

fertilizer of the above grade, it will take of the very best concentrated materials that can be bought some 1920 lbs., leaving only a chance for 80 lbs. of filler. The farmer thinks this high at $42.00 per ton, and in many cases will turn around and buy a 2-4-5 and pay $25.00 per ton and think he is getting a bargain. The facts are, he is only getting just half of the amount of plant food he would in a ton of 4-8-10. In other words, he would have to buy 2 tons of the 2-4-5 to get as much plant food as he would get in one ton of the 4-8-10, costing him $50.00 instead of $42.00, or eight dollars more. If this was all of the extra cost, it would not seem so bad, but he has got to draw and handle that extra ton of weight, which means, if he is some miles from the railroad, several dollars more.

There are practically only three things that a farmer wishes to buy when buying commercial fertilizers; these are nitrogen, phosphoric acid and potash, and it is well to look at the sources from which these come. Taking nitrogen first, there is nitrate of soda, which is a salt mined from the Chilean nitrate beds; meat tankage, dried blood, sulphate of ammonia and cottonseed meal. These are all good forms. Then we have other and more inferior sources, like ground leather scrap, wool waste, hoof and horn meal, and some others which it is not necessary to mention.

The user of fertilizer should remember this one thing, that no plant can take up its food, whether furnished by barn manure or fertilizers, only when that food is in solution. It has got to be dissolved in water before it can by any possible means be taken up by the plant roots and used to build root or stock growth.

Nitrate of soda is the most quickly available of any form of nitrogen. Just as soon as it comes in contact with damp soil it begins to dissolve, and as soon as dissolved it is ready to be used by any crop. For this reason, it is not best to have any of the nitrogen content of a fertilizer in the form of nitrate of soda when any of the fertilizer is to be applied either before or at the time of planting potatoes. Every potato grower knows that it is from two to five weeks after planting potatoes before there is any root system to take up free nitrogen. Therefore, if any of the nitrogen content of the planting brands of fertilizers is in the form of nitrate of soda, the potato grower stands a fine chance of losing a part of this high-priced element of his fertilizer by

having it washed from his soil by rains long before the potato plants can get any root growth to feed upon it.

Nitrate of soda is all right to use in a potato fertilizer for a part (not over one-half) of the nitrogen content for the hoeing or top-dressing brand, as this will be if properly used, applied after the plants have broken ground and got more or less of a root system.

The next quickest available form in which we can buy nitrogen is dried blood. This, being organic matter, must decompose or rot in the soil before any of the nitrogen which it contains can become water soluble or available for plant food. This decomposing or rotting will not take place to any appreciable extent until the soil temperature reaches or goes above fifty-five degrees Fahrenheit. Thus it is perfectly safe to have at least a part of the nitrogen content of the planting brand of a potato fertilizer in the form of dried blood.

Sulphate of ammonia would come next in availability, and while some claim that it is not as good as the organic forms of nitrogen, a certain portion mixed in works all right in the planting brand.

Meat tankage, especially the best grades, where they contain a certain amount of finely ground bone, are a fine source for a large part of the nitrogen content of either brand. For here, as in dried blood, decomposition must take place before the nitrogen can become available, and with a percentage of the tankage ground bone, which takes much longer to rot, there will be nitrogen becoming available all through the crop-growing season. This is of more importance than a great many give it, as a potato crop needs some nitrogen, even in the later part of the season, if we are to feed it so as to have it do its best.

Ground leather scrap, wool waste, hoof and horn meal, while they are sources from which nitrogen can be obtained by the commercial fertilizer manufacturer to make a good analysis, are but little, if any, good to the potato grower. Take, for instance, ground leather; while it gives a very good nitrogen analysis, something like seven to eight per cent., practically none of it would become available for any crop. Probably there is not any of our soils which were once good, no matter how worn out and unproductive they may seem at present, but what contain nitrogen enough to produce many maximum crops were it available. What, then, is the use of any farmer or potato grower to buy fer-

tilizer that has any part of its nitrogen in these unavailable forms, like ground leather? The chemist in his laboratory with his powerful acids can find and determine the amount of nitrogen they contain and make a good showing on the fertilizer bag; but the plants, working in their soil laboratory, are unable to break down and liberate it for their use, and it is of no more use to them than any of that other locked-up nitrogen which even many of our poorest soils contain.

The nitrogen analysis on the fertilizer bag does not tell the whole story, because it does not differentiate between the plant food sources of nitrogen from those for analysis only. For this reason, a fertilizer manufacturer can give as high an analysis as a 4-8-10 goods, and by using these insoluble and unavailable forms of nitrogen make a saving in cost to him of between five and seven dollars per ton. Thus the honest fertilizer manufacturer, who is putting out goods containing actual plant food nitrogen, has got to face the competition of those less scrupulous, who use the insoluble forms, at many dollars less cost per ton to manufacture, but who are allowed by laws in many states to have the same guaranteed analysis on the bags.

There must be in the near future either a change in the fertilizer laws of the several states or the user will have to depend upon men whom he knows to be personally honest to make up fertilizer for him. This has been the experience of

Photo No. 11. Showing the works of the Union Chemical Co., North Wales, Pa.—the home of the Ideal Potato Manure—planting and top dressing brands—two brands with the same analysis, but different in the nitrogen contents—the only brand made to meet the requirements of the growing potato in a conservative, scientific manner.

the writer, who, knowing the market prices of the highest grades of chemicals, has gone to an independent fertilizer company and had what fertilizer he and his associates needed made up out of honest materials, and paid an honest price for them, regardless of the fact that he could buy the same analysis of many manufacturers at a saving of about $8.00 per ton, but who do not, and will not, state the sources from which the different plant food elements are taken.

Again, most fertilizer manufacturers have but one brand; that is, they do not differentiate between what they expect the potato grower to use when he plants his crop and what he should use later on, when the potatoes have broken ground and have a root system. Therefore, many of them use nitrate of soda as part of their nitrogen content, which would be all right for crops which quickly form a root system, but which may and many times does cause a loss to the potato growers, as I have above pointed out. This loss would be greater on sandy soil or any soil underlaid with a loose or porous subsoil.

The most practical way is to have the potato fertilizer in two brands, both a 4-8-10, but with no nitrate of soda in the planting brand, but in the hoeing or top-dressing brand, which is to be applied after the vines break ground. Quite a percentage of the nitrogen should be in the form of nitrate of soda. There is one independent fertilizer company, the Union Chemical Works, of North Wales, Pa., which is today putting out a potato fertilizer made up in these two brands. As far as the writer's knowledge goes, they are the only manufacturers of fertilizers in the country who have recognized that there is as much science in feeding food to plants as there is in feeding livestock. Mr. Warren Fretz, of Bedminster, Pa., who has probably done more to build up the potato-growing industry of Pennsylvania in the last few years than any other man, after carefully going over this matter several years ago with the writer, originated and had brought out the two brands made by the above company, and known as the Ideal Potato brands. Both of the same analysis, but differing in the make-up of the nitrogen content. Photo No. 11 shows a view of their factory. These brands, rightly used, have given some of the best yields obtainable, both in Maine and Pennsylvania, for several years.

There is quite a fad in some sections among potato growers to buy chemicals and mix their own fertilizer, some

claiming a great saving in cost. Those making this claim are almost invariably those who have been buying the cheaper brands of fertilizer, and paying much more for them than the analysis would warrant. Again, home-mixed goods of the same analysis seldom give as good results in the field as do those mixed by the manufacturer. For instance, the farmer buying chemicals in comparatively small amounts seldom gets his material in as many different forms as the manufacturer has at hand. In the case of nitrogen, for an example, the grower who buys chemicals seldom gets his nitrogen from but two sources, usually nitrate of soda and tankage, while the fertilizer manufacturer, having other sources readily at hand, makes up part of the nitrogen content out of these, thereby coming much nearer to giving the growing crop a steady, moderate supply the season through. Then, again, a well-equipped factory will get the materials better mixed and in a more even manner than the home mixer. The home-mixing fad seldom lives but a few years in a place, and it is safe to say that the percentage of home-mixed fertilizer used by the potato growers of Maine is so small as to hardly be reckoned with. Maine, more than any other state, grows its potatoes on commercial fertilizer, and had there been any great saving in home mixing the Maine potato grower would have been at the fore in the home-mixing idea years ago. The safest way is to get the high-grade fertilizer, buying of reliable firms.

CULTIVATION

Many farmers have an idea that cultivation begins after the crop is planted. My way of thinking, this is not so. Cultivation of the crop begins as soon as the soil preparation starts, and if the soil has been prepared as I have described under "Preparing Land for Potatoes," cultivation is half done before the potatoes are planted.

There is no way in which the soil directly under the rows can be fined and loosened after the potatoes are once planted, hence, if this is not done before planting, it cannot be done at all, and of all the soil in a potato field, there is none which should be in better shape for crop growth than that directly under the rows.

After planting there should be at least two deep cultivations. A two-horse double cultivator will do deeper and better work and more of it in the same time and get up near-

er to the rows without disturbing the seed than can be done with a single-horse cultivator. As soon as a field is planted with the planter the cultivator should be started, running it as deep and as near the rows as is safe to do without disturbing the seed. The wheels of the planter will have packed down the soil between the rows, and this cultivation will loosen it up, allowing heat and air to better penetrate it. As soon as this cultivation is finished the weeder, brush-harrow or plank drag, should be used to work the ridges the planter left over the rows down level. This

Photo No. 12. Showing a properly fertilized field of potatoes—photo taken July 8, 1912. Photo No. 13 shows the same field ten days later. Field of Dr. C. M. Twitchell.

extra soil over the rows prevents the air and heat reaching the seed and is of no value to it. On the contrary, it will retard the starting of the sprouts, and in case of rains may seriously injure them, causing a weak, spindling growth. We do not want any more soil over our seed than

we are obliged to have until the plants are well out of the ground, especially when we are planting from three to four inches deep after the ground is smoothed down level. For this reason the ridges over the rows as left by the planter should be left after planting only long enough to guide us in our first deep cultivation. This should be done as quickly as possible after planting.

The field should be gone over every few days with the weeder, until the sprouts get near enough to the surface so that some are broken off, then its use should be discontinued until the vines are well enough established so that the weeder will break off but few, if any. Many continue the use of the weeder regardless of this breaking off of many of the sprouts, and perhaps in a hot, dry time the use of the weeder will do the balance as much good as the harm it has done to those it has broken off. One of my fixed rules is never to run my cultivator so as to break or cut off any portion of the root system; or to break off a sprout with the weeder or any other implement where I want a plant. If the seed piece has vitality enough to send up another sprout, it is weaker and later in maturing, and in case of early potatoes, a practical loss.

When the potatoes are well up, so that the rows can be plainly seen, give them the second deep cultivation, running the cultivator well up near the rows, but being careful not to run near enough to cut off any portion of the root system. This will kill all the weeds between the rows, but there will be many along the rows which we cannot get with the cultivator. **The plants are now ready to receive the second application of fertilizer. If the nitrogen in this second application can be largely in the form of nitrate of soda, as the plants now have a root system in a condition to take it up, it will force a very rapid growth. (See Photos Nos. 12 and 13.) For applying this second application of fertilizer the planter can be used by taking off both plows, but leaving on the fertilizer attachment and the disk covers. We can now drive right over the rows, drilling the fertilizer right along, and with the disk coverers burying the fertilizer, weeds and potatoes. If the potatoes have come up stocky and strong, they will push right up through this loose soil with which we have buried them up. All little weeds will be killed by this process. (See Fig. 14.)**

The disk coverers should be set wide enough apart

to make a broad, low hill or ridge, throwing some three inches of soil around and over the plants and fertilizer which we have drilled along the row. The vines will at once send out one or two new sets of roots above this

Photo No. 13. Showing the marvelous growth of potato vines in ten days time when properly fertilized and protected from insect injury. Photo taken July 18, 1912 on field of Dr. G. M. Twitchell, Monmouth, Maine.

fertilizer; in a very few days the earth around this fertilizer will be found literally full of new white feeding roots which the plants have sent out.

This burying process is, as far as I am able to learn, a distinct Maine practice. I am not in favor of extreme ridge or hill culture, but have never been able to get as large crops and of as good tubers unless hilled moderately. With this method, there is little, if any, root pruning, which I believe to be, one year with another, one of the worst practices a potato grower can indulge in. It is far

better to make two applications of our fertilizer, and it is a waste of nitrogen in the fertilizer to apply a portion of it broadcast before planting if any portion of the nitrogen is in the form of nitrate of soda. There is no way so economical of labor and time as this method of applying. Both the fertilizer and burying can be, and is done, with one driving over the field. This burying of potatoes, especially early varieties, should be done when they are just well up, so that the rows show plainly. On the later and more vigorous varieties it can be done without injury even when they are from four to six inches high. (See Fig. 14) Many of the plants on this field were six inches or more high, and as the field contained more or less witch-grass and many small weeds, the potatoes were buried from four to six inches. **This method kills out all the weeds and grass and causes the potato to send out new root growth. The plants will force right up through this covering in about two days' time. Time required is about one and one-half hours' work per acre.** Figure 15 shows the same field at the last spraying, September 16, 1909. On early kinds, burying when too large hurts their growth, especially if covered too deeply; for this reason, on early varieties it is advisable to so adjust the machine that they will not be entirely buried unless the weeds have got a bad start, when everything should be covered out of sight and deep enough to kill all weeds. The growth of weeds or the cost of hand labor to remove them would be more than the probable damage done the potato vines by burying them; much depends on whether the potatoes have come up strong and stocky; if weak and spindling, they will not stand so deep covering without injury. Vigorous, stocky plants will shove right up through several inches of loose soil and in about two days' time. If some of the fertilizer falls on the leaves, no particular harm will be done; the plants shove up through by making new growth from the centre, and all leaf growth covered remains buried and performs no further leaf functions to the plant.

There are two advantages right here, as any eggs of the potato beetle which have been laid on the little plants previous to this burying will be destroyed. In some cases these will be the greater portion laid on the field during the season. Another is the fact that the plants will send out a new set of roots from each joint of stalk which is below the surface of the soil we have

Photo No. 14 Showing method of applying the 2nd application of fertilizer (Topdressing brand) as practised in Maine This method kills all weeds along the rows not reached by the cultivator—taken July 12, 1909, on one of the Author's farms.

thrown up around them; this enlarges the root system. The application of fertilizer at this time, and placing it where the plant can immediately feed upon it, more than offsets any temporary check any good vigorous stalk will sustain when small by covering it with loose soil, even to the depth of several inches. The cultivator should be run through between the rows immediately after this burying of the plants to loosen up the soil between the rows and prevent evaporation of moisture. If little weeds spring up along the rows again, a second hilling is sometimes advisable. Only enough soil should be thrown up and around the plants at this time to smother the weeds and to form a dust mulch; usually it is not advisable to make this second covering. The grower should be governed by weather conditions and the growth of weeds in making this second hilling; it must always remain largely a matter of individual judgment.

The last working of the field should be with the cultivator narrowed up so as not to tear down our ridges and run very shallow, just enough to form the dust mulch between the rows. This system of cultivation might not be applicable to many sections where dry weather is the rule every summer. In the worst drouth we have had for years here in Maine it has given fully as large crops as any system of level culture where the cultivator is run very close to the rows when the vines are from six inches to a foot in height. This is many times done when the teeth of the cultivator are loaded with the feeding roots of the potato at the end of every furrow; this is root pruning and deprives the plants of just so much feeding capacity. With the soil thrown up around them, if done when and as it should be, there will be no root pruning. On the contrary, there will be thrown out from the stalks many more roots, greatly increasing the plants moisture-gathering capacity and more than offsetting any saving in moisture there might come from level cultivation. Each grower will have to figure this out for himself and for his own particular soil and climate. My province is to set down the facts as far as my experience and knowledge goes and not to argue for either the level or ridge system of cultivation. Potatoes grown in the ridge system are more easily dug than with level culture, and in a wet season are not so likely to rot. There are less sunburned tubers, and a moderate ridge system of cultivation would seem, one year with

another, to have more advantages than either level or extreme ridge culture.

INSECTICIDES

In treating of insecticides, I shall take them up under three divisions, viz: Paris Green, Arsenate of Lead and Bug Death, setting down in an impartial manner the objections and limitations of each, giving those not familiar with them a chance to decide for themselves.

The use of the deadly arsenical poisons has grown to such proportions that thoughtful men may well pause and ask whether or not there will come a time when the soil itself will become so impregnated with arsenic as to kill all vegetation.

A few years ago any one advancing such an idea found himself ridiculed by many of the State Ex. Stations, the Stations claiming that the arsenic was, for the most part, insoluble, and that there could be no danger from this source.

I have only to cite the Orchards of Colorado to prove how wrong was the advice given to the farmers of this country by so many of the Ex. Stations. The loss to the orchardist of Colorado alone will already run into the millions, for there is hardly an orchard in the state fifteen years old which has not suffered severe loss by trees dying from arsenical poisoning. Tens of thousands of trees have already died, and whole orchards are rapidly becoming worthless, simply and wholly from the arsenic which has been sprayed upon them to kill insects. What condition the soil will be in to produce other crops after these orchards are entirely gone no man can tell for a surety. That it may become actually worthless for crop production of any kind is the opinion of many, and this seems plausible. The insolubility of the arsenical poisons in any soil has been proved a myth, not by the Ex. Stations, which advocated their use, but by the orchardist and farmer in his field work. No more severe indictment of many of our so-called scientific men could have been conceived than is shown by these dead and dying orchards of Colorado and their ruined owners. That the potato grower who uses arsenical poisons to fight the insects on his vines may and will come to the same condition is only a matter of time; but in the case of the potato there

Photo No. 15. This photo shows the same field as No. 14—taken Sept. 16 1909. and shows the grower how well the plants will come up through the burying as shown in photo No. 14.

is a far more insidious danger, which I have described under the causes of the running out of the potato. Already this has done untold damage to the vitality of the potatoes East of the Rocky Mountains.

Here is another severe arraignment of the Ex. Stations. For the last fifteen years they have known that it was not necessary that these deadly poisons be used for this purpose, yet I have to learn of the first instance where they have come out openly and told the potato grower the truth. Fifteen years ago there was a concern in Massachusetts which started making the insecticide, called Bug Death, which contains no arsenic. They carefully tried this out on every garden plant, and found that used in liberal quantities it was equally as effective as any arsenical poison, and containing no arsenic it was harmless to any plant or animal. They then submitted it to the Ex. Stations of several of the New England states for trial, thinking that the Stations would gladly welcome the use among the farmers of any material which would make it unnecessary to use the deadly arsenical poisons. To their intense surprise they were met by ridicule. A notable instance of this was when the Director of the Maine Ex. Station devoted nearly nine pages of a bulletin issued at that time for this purpose.. Not in a single instance did the manufacturers have an offer of co-operation from any Ex. Station; neither was there the slightest disposition on the part of any of the Ex. Stations to offer their services to the manufacturers to the end that a better insectide might be obtained than what was first brought out.

If there has been any effort made by any Ex. Station in the country along the line of getting any insecticide which will kill insects, and not in any manner injure the plants, the author has never heard of it. On the other hand, every effort has been made by the Stations to block the sale and retard the use of such when put upon the market. I know of but two states in the country where an institute speaker dares to speak favorably of Bug Death for killing insects without danger of losing his job on the force. These states are Maine and Pennsylvania, and what is more significant, and what gives a sinister look to this whole opposition, is the fact that in these two states the Farmers' Institutes are not to any degree under the influence of the Ex. Stations.

I have a personal knowledge of a case where the director of Institutes frankly told the speaker that he had done the best work of any man he had every employed along the speaker's particular line, yet, because he answered some questions from the audience favorable to the use of Bug Death for combatting insects, that speaker was dropped from the force, and to this day has never been called back to that state. More than this, the Station knowing the standing of this speaker on this subject, insisted that the Institute director allow them to have a man from the station on the force to spy upon him, and report to the Station his remarks, and that the question which he answered which resulted so disastrously for him as an Institute speaker in that state was instigated by the Station's spies.

The author was talking potato culture to a New Hampshire audience several years ago, and had spoken favorably of Bug Death as a means of fighting potato-eating insects when he was interrupted by Prof. E. Dwight Sanderson, of the New Hampshire College, an Ex. Station, who demanded to know why, if what he said was true, Woods, of the Maine Station, had made such an unfavorable report on it. My reply was that if Woods had made any such report as he had without knowing whether or not he was right, it did him no credit, if he had made the report which he had sent out knowing that it was false, it looked black for Woods, and in either case it did the Station no credit. A lively discussion followed, and so many people supported my position by reciting their own experience, which tallied with my own, that the Professor saw that he would be entirely discredited if it went on. He again took the floor and acknowledged that as far as potatoes were concerned he had no personal knowledge of what the material would do on potatoes, but had simply taken the Woods report from Maine, and to save himself from being utterly discredited for attacking the speaker on a subject he had to acknowledge he knew nothing about, he made this surprising statement, that as far as potatoes were concerned he knew nothing of its value, but he would say that for the striped squash and cucumber bug that it was the best and only thing he had ever found that he could successfully combat this pest with. By acknowledging that when used for this purpose it afforded complete protection against these pests he saved his self-respect before that audience.

Here was a man who every farmer and every consumer was helping to support; also the Institution of which he was a part, and neither he nor the Station has ever, to the writer's knowledge, made public to the people this knowledge, which is worth thousands of dollars to New Hampshire alone. This is a typical case. The farmers and consumers of this country are taxed to support the Ex. Stations, and yet knowledge which is vital to the production of crops is withheld, because it did not originate with the Stations themselves, and does conflict with some of their preconceived theories. I do not mean to charge this to be true of all the Ex. Stations. There are some who deal plainly with this matter, and I advise any of my readers to write to William P. Headden, of the Colorado Ex. Station, Fort Collins, Colorado, asking for his bulletin No. 131, printed in July, 1908, and No. 157, printed in May, 1910, on arsenical poisoning of fruit trees. These should be read by every orchardist in the country.

With a few exceptions like the above, if my readers doubt the influence that the Ex. Stations have over the speakers at Farmers' Institutes, let them closely follow any speaker in any state where the Farmers' Institutes are connected with the Ex. Stations, and see if the speakers are not continually praising the Stations and urging the farmers to insist that their legislatures appropriate more money to them. Note, also, in far too many cases the type of men employed as speakers. Are they men who have made a success of farming in any of its branches? No, they are men who work the farmers to get them to vote more money to the Stations, and the actual problems of the farmers are a side issue.

Now that they have led the orchardist of Colorado to the point where the loss to the state runs into the millions, if it has not entirely ruined for generations to come large tracts of the best agricultural land in the state, will we see any halt along this line of booming arsenical poisons on the part of the Ex. Stations in states not yet affected.

To answer that question we will have to inquire as to the ownership of the arsenic mines in this country.

It is very little use to lock the stable door after the horse is stolen, and what good will it do the potato grower to inform him a few years hence that he has

ruined his fields by the use of arsenical poisons? He will know that then without being told. The proper mission for the Ex. Stations is to inform him now of means to fight his insect pests without any danger of poisoning his soil, and a further and more insidious danger in the case of the potato of weakening its producing powers by sapping its vitality year after year. Right here I know of no way that I can bring these facts more forcefully to my readers' attention than by quoting from the above-mentioned bulletins.

I deem this question of arsenical poisoning to be one of the most important that confronts the agriculture of our country today, and that the Colorado Station should have the thanks of the whole country for the work it has done through William P. Headden. The Colorado bulletins on this subject, Nos. 131 and 157, are so valuable that I would like to quote them entire, but space forbids, and I will have to content myself with the following extracts: *"The number of trees affected. * * * One man stated that in the last few years he had lost 50 per cent of his Ben Davis. * * * * I visited one orchard in which there was a large number of affected trees; in other orchards there are only a few. The total number of affected trees in the orchards of the Western Slope is already, unfortunately, large. I have already clearly indicated my conviction that the cause of the trouble is arsenical poisoning; that there are some trees suffering from other causes is quite certain, but the cause of the greater portion of the trouble is the arsenic, which has acculated in the soil. The expression of this conviction is not a hasty one, for I am fully alive to how much it means to this state and all other orchard-growing states, where similar soil conditions prevail, but it is for the best interests of orchardists that they should know the facts pertaining to the death of their trees and the conditions of their soil."*

*"The Accumulation of Arsenic in the Soil."—The number of sprayings applied varies from two or three to nine during the season. * * * * The amount of lead arsenate used is from four to six pounds to each 100 gallons of water. The average orchardist does not consider the amount of arsenic thus applied to a single tree a very large quantity. * * * * Practically the whole of this eventually finds its way into the soil. * * * * It is not done one year only, but every year, * * * * so*

*that we would expect to find a considerable accumulation of arsenic in the soil, especially in the soil at the base of the trees. This corresponds to the facts as found by analysis. In one sample taken beneath the head of a twelve-year-old apple tree, and representing the soil to the depth of five inches, I found arsenic corresponding to 30.6 parts of arsenic acid to each million parts of the soil. * * * We find, in fact, what was from the beginning patent; namely, that the arsenic does accumulate, and is already present in our orchards in dangerous quantities, if it, by any means, should become soluble.*

*"The Arsenic Is Taken Up by the Trees."—It is altogether correct that the spray material applied is a compound of arsenic, either difficulty soluble or insoluble in water, as calcic arsenite or lead arsenate. It is also true that literally hundreds of trees have already died or are sick, as, I believe, beyond hope of recovery. * * * * We have seen that the arsenic is accumulating in the soil, having already reached as large an amount as 66.33 parts of arsenic acid in a million of soil. * * * * Further, we have shown that in these dying trees arsenic is present in the roots, the trunk and branches varying up to 12.77 parts per million. * * * * I have stated my conviction that many trees have been killed by arsenic, and that others are hopelessly sick. I will give some reasons for my belief. First, it is a well-known fact that soluble arsenical compounds will kill plants. It has been found that Herbicide, a preparation found on the market, is essentially a solution of an arsenical compound. Both white arsenic and arsenic acid have been shown by various experiments to be deleterious even when present in very small quantities, one part per million in solution.*

"Second. I took some green house plants, coleuses, daisies and geraniums in two and a quarter and three inch pots, and added from 0.05 to 0.5 grams, approximately from 3-4 of a grain to 7.5 grains, of sodic arsenite, and the smallest amount used sufficed to kill the plants.

*"Third. I know of two trees, one killed outright, * * * * and the other partially killed. It was my good fortune to see this tree when the affected limb was still on the tree with the dead and blackened leaves clinging to it. Inquiry elicited the statement that it had been killed by arsenic, as the other tree had. In the case of the tree that had died, they had made arsenite of lime under it or near it, and*

*had probably spilled the arsenite of soda. In the case of the tree, one limb of which was dead, they had been more careful with their sodic arsenite. Having some left over, they determined to get rid of it, and emptied it into the irrigating ditch near the tree. This was one day in June. Two days later the limb was sick. I saw it in October when the limb was dead and had the appearance of having been dead for some time. * * * * I measured the distance from the trunk of the tree to the irrigating ditch, * * * * * and found it to be 12 feet. An examination of this tree showed that a section of the bark from the base of the trunk up into the big limb was brown, sunken and in appearance like the bark in the trunks of affected trees. The wood beneath this bark was dead and colored brown. * * * * The condition below the surface of the ground was even still more striking, or the bark was destroyed and the little that remained was very dark, in places black. We dug out this root, following it to the irrigating ditch, to the point where the sodic arsenite had been emptied. * * * * The killing of the bark and woody tissue was in this way traced from the point at which the sodic arsenite was introduced into the ditch through the small roots into the large one, thence into the trunk, the limb and even into the branches. The course was direct, and the flow of the poisonous solution was confined to a comparatively narrow channel. * * * * We have not simply assumed that the placing of sodic arsenite in the ditch and the dying of this branch of the tree two days later are wholly conclusive as to the cause of death. I have examined the wood of the branches and the root, and find an abundance of arsenic in both. In this case I recovered the largest amount of arsenic found in any sample, * * * * corresponding to 34.5 parts of arsenic acid in one million parts of the tissue. The other portions of this tree were apparently in good condition when I last saw it. * * * * I have given this case in some detail, because I believe it to be as conclusive proof as can possibly be adduced that soluble arsenic compounds not only produce death when introduced into the circulation of the apple tree, but will produce the effects which we find preceding the death of our apple and pear trees. In both cases we have the killing of the bark, the staining and destruction of the tissue and the killing of the trees. * * * * I have now given the reasons for my conviction that the arsenic which has accumulated in our soil from the use of arsenical sprays used in*

combatting the codling moth and other fruit, leaf and bark-eating insects is the cause of this trouble. To restate them succinctly, we find the arsenic already accumulated in the soil to an extent far beyond the danger line for solutions as established by competent experimenters. We find it also in the tissues of the plant, where it is not normally present. We have proved both in the case of herbaceous and woody plants that soluble arsenical compounds will cause their death. I regret that I can see no other conclusion than that the corroding of the crowns, the killing of the bark, the staining and final destruction of the woody fiber, the early dropping of the leaves presaging the early death of the tree and its final death a few months later are caused by arsenical poisoning."

All of the above quotations have been taken from Bulletin No. 131, dated July, 1908. I will now quote from Bulletin No. 157, May, 1910:

*"I gave in Bulletin 131 a definite experience with a case in which it was charged that arsenic, lead and copper had been the cause of the death of trees, grass and even of animals eating the grass, and I am fully convinced that there is great danger of our adding arsenic enough in the form of materials used for spraying to jeopardize not only the life of the trees, but bring about other conditions of a most serious character. I have heretofore been very careful not to condemn the practice of spraying, but simply to call attention to the dangers accompanying the practice, and particularly the excessive application of these poisonous preparations to the trees, and eventually to the soil. * * * * Up to the present time we do not know of any other practical and effective means of protecting our fruit against the codling moth than some form of arsenic, and so far as we now see we must continue to use this means. This, however, does not mean that we cannot improve the practice in several ways. * * * * A still greater improvement would be to obtain some substance which would furnish our fruit the desired protection, but which would be entirely free from the serious objections which apply to the use of any arsenical preparation. This is not an impossibility. * * * * The assumption that the arsenical preparations used for spraying are insoluble in water is not justified, and yet this is a condition which they must fulfill in order that they may be safely used. Further, conditions may, and in some cases certainly do, exist in the soil which makes them more soluble than they*

Photo No. 17. Showing the effects of arsenical poisoning on potato leaves from Paris green. No potato plant can produce a full crop of tubers when suffering from injury of this kind.

are in pure water. I have met with many men to whom it was a matter of some surprise that the arsenic might accumulate in the soil, though they knew that the amount of soluble arsenic in the soil might increase with the years."

*"The Number of Trees Affected."—Under this caption, in Bulletin 131, I stated that it would be difficult to obtain data on which to base even a rough estimate of the number of trees suffering from this trouble. I have visited many orchards since I wrote the above statement, and am now convinced that it is difficult to find a fifteen-year-old orchard in the state wholly free from this difficulty. * * * * I am convinced that the number of trees already seriously affected by this trouble are not numbered by hundreds, but rather by tens of thousands. * * * **

We have been using arsenical sprays in the various parts of our country for various purposes about 40 years. We have been spraying our apple orchards about 28 years, and in Colorado we have been spraying 18 or 20 years. The question is what has been the effect of this in regard to the amount of arsenic in the soil. The answer is given above, i. e., that even in Colorado we have increased the arsenic content of our orchard soils at least tenfold, and in the older states it must be even worse if they have been nearly as zealous in spraying as we have been.

But few people consider the real character of the sprays used, and we cannot expect the ordinary orchardist to consider the possible results, and there has been an abuse of the practice. The practice in this sense has been a dangerous one.

"Trees That Have Not Been Sprayed."—I introduce this subject for the simple reason that through this claim for certain trees I found some very instructive and interesting cases. It is a very common thing for persons to state that "those trees have never been sprayed." I have been deceived by this statement so often that I now pay no attention to it at all. I have examined too many trees that "have never been sprayed," and found arsenic, copper and lead present, which I consider as establishing a strong presumption that the tree has been sprayed. In this instance, however, I know the owner personally, and he was so positive, and his statement was corroborated by at least one other member of the family, that when I saw the trees, which I thought were surely not sprayed, I did not know what to think. I at once saw that I had to examine at least two of the trees, for if these trees had not been injured by arsenic, then I had at last found an

instance of apple trees with corroded crowns and all the other conditions which I had been attributing to the irritant action of arsenic which were not due to this cause. I took samples of the corroded roots of two trees, and found arsenic without any trouble. I knew that my friends had not tried to deceive me, and was certain that an explanation was to be had. I suggested to them that potatoes might have been grown between these trees and had been sprayed with Paris green or possibly lead arsenite. This proved to be the case, and while the trees had not been sprayed as apple trees, they had been sprayed with the potatoes.

At this time it is impossible to learn whether these trees had ever had the poison applied directly to the body of the tree or not. A few points, however, are established: That the crowns of these trees were girdled, the roots were corroded, arsenic was present in the woody tissues of the trees. The trees have since died. They were never directly sprayed as apple trees, but potatoes were grown between these trees, and were sprayed with Paris green in the earlier years of the orchard, and later with disparine, a trade name for arsenate of lead."

I have examined a number of samples of apples and pears from Colorado and other states, namely, from California, Michigan, New York, Pennsylvania, Ohio and Illinois, and found them all to contain arsenic. Some of these samples were bought in market, but for others I am indebted to the officers of the respective Experiment Stations, and it is a pleasure to acknowledge my obligations to them. I may state in this connection that the above fact is not the only one indicating that other states where spraying has been diligently practiced are suffering as we are, but not to the same extent.

The author has quoted largely from these bulletins of Prof. William P. Headden, for the results shown tally with the author's own experience as to the danger of the use of arsenical poisons. I believe there is as much danger today in Maine from the use of Bordeaux mixture as there is from the arsenical poisons in poisoning the soil. In many parts of the state there are potato growers who use from 25 to 40 or more pounds of copper sulphate per acre each year in spraying with Bordeaux mixture. That this amount of copper sulphate can be used without danger to the vitality of the tubers grown when used year after year I do not believe. Five years ago I had a barrel con-

Dr. G. M. TWITCHELL, Auburn, Maine.

One of the foremost thinkers along agricultural lines in the country today. For thirty years devoted entirely to study of and experiments in agriculture. Never with a thought of personal gain but that he might in some way serve his brother farmers and aid in promoting the one industry most vital to the enduring life of the nation.

taining about fifteen gallons of copper sulphate water, one pound to the gallon left at my last spraying in September. This stood at one side of the potato field on the sod ground. This was an old turf composed mostly of red top and June grass, and was very thick. The barrel containing the fifteen gallons of copper sulphate was upset by some one, spreading over a place several feet across. The grass and turf was entirely killed out as far as the water reached, and there has been neither grass nor weeds of any kind grown on this spot in the five years since.

That the result of using Bordeaux mixture where a potato rotation of once in three years is practiced, especially the amount used by many, can fail to be anything but harmful to crop production in the near future goes without saying.

It is through the leaves that the potato plant is enabled to store starch in its tubers and make quality. Dr. G. M. Twitchell, of Auburn, Maine, who is one of the foremost Institute speakers Maine ever produced, has set this out far better than I, a plain farmer, can do.

Dr. Twitchell Clearly Explains this in the Following Article

With natural increase in interest in potato growing, there follows the necessity for a like increase in attention to the subject of spraying, for the reason that is the only path by which we can insure a healthy, normal or satisfactory crop. Being in business for a livelihood, it behooves every farmer to consider what may be the conditions ten, twenty or thirty years hence. Population will have doubled by that time, but not cultivated area, hence you must prepare for increase of crop per acre. Going still further, we find that, in the study of food by the public, the time is at hand when the value of any food product will be determined, not by the mere fact that it is a food product, but by the actual food value enclosed within its skin or shell. The potato grower must be preparing for the day, not far distant, when price realized will be fixed by food content in the product, when his potatoes must carry a higher per cent. of starch, that being the element which insures quality. To get this, more attention must be given to protection of the leaves, as well as soil, from any and every agent which might detract from the perfection of the tuber. No man has yet learned the

secret of maximum production. A great undiscovered country opens before the aspiring grower, but to enter he must know that his soil is free from harmful minerals, and his vines protected throughout the season from all insect pests and fungus diseases and *certainly from the possible injury to leaf and stalk by the use of arsenical sprays.* Infinitesimal damage to leaf structure, damage revealed only by the magnifying glass, will reduce the starch content in the potato, as well as yield per acre. The relation spray solutions hold to financial net returns to the grower are not realized. It is a sad mistake to figure upon the basis of first cost. Final yield and food value alone can determine. Arsenic kills, therefore use arsenic, is the sum total of the advice given by those set to aid the farmer. If there was no other agent, or combination of agents, which will protect, without injury, the danger from pest and disease might justify this cry. So far as known, no attempts have been made by the scientific workers to find any other effective, yet absolutely safe agent, for the farmer to rely upon. It has been fully demonstrated that it is practically impossible to use Paris green without doing injury, yet, in view of this fact, this agent is today being urged as most effective and economical.

Arsenate of lead is far preferable, less injurious, and protects for a longer period, but both have value only from the arsenic they contain, and this is an indestructible mineral, finding its way into the soil, never to be removed, and increasing with every year's use. Some day this must be reckoned with by the potato grower and orchardist, hence, it becomes vital that we rely upon agents free from all possible danger to crop or soil, and promotive of growth and quality. For eight years I have used nothing but Bug Death on potatoes, garden crops, also on all fruits, and also for pests on apple trees and fruit. When some machine is perfected, so that as thorough work can be accomplished in dust-spraying apple trees as are now available for potatoes, and all small fruit and vegetables, I am forced to believe that protection will be complete and the delicious apple can be offered the purchaser absolutely free from all taint of arsenic.

Economic conditions, growing more exacting every year, force a constantly increasing study of this problem of quantity and quality, and, if it results in more complete mastery of the subject of preparation, care and fertilization, it must also lead to as critical study of the safest, surest means of protecting growth and leaf development that greatest

value may inhere in the finished product. Here is where the net profit of the future grower is to be found and the business established. The day is near when guarantee of starch content will open wide the door to a market the value of which cannot be estimated. It is showing itself in the demand already active for graded potatoes, packed in bushel boxes, every potato wrapped in paper. The step is short from here to that of guaranteed quality based upon per cent. of starch.

To obtain this it behooves the grower to give close attention to the insecticide he uses and think of cost only as related to quantity and value of the perfected product.

GEO. M. TWITCHELL.

PARIS GREEN

Paris green is today the most universally used of either for killing the potato-eating insects. It is a copper compound of arsenic and a deadly poison, and should never be kept where children or stock can reach it. Its action on foliage is harmful; many farmers who have applied to potato fields a little too strong solution of Paris green have killed them entirely. Others have noted when a weaker solution was used that their fields turned a lighter green, losing their thrifty appearance and becoming a ready prey for blights. Many farmers claim that it is the cause of the late blight or rot; this is true only in the sense that its use so weakens the plant that the power to resist this disease is lowered. Its depressing effects on the vines are greater if the leaves have been more or less eaten by insects; this is specially true of the work of the flea beetle, which it does not kill to any appreciable extent.

The reader will get a better idea of the injury done the potato plant by Paris green by referring to Figure 17, showing injury due to arsenical poisoning.

Some authorities claim that this is wholly due to the free or water soluble arsenic which the green contains, and that the addition of lime will prevent all injury. To a certain extent, this is true, and the user should always use more or less lime in any mixture containing Paris green which he sprays upon his potato vines. That this injury can be wholly overcome by the addition of lime has not been the experience of one of the greatest potato experts I have ever known. Neither has it been true in my own case. That its use on

potato fields will, in time, impregnate the soil to the extent that it will impair the growth of vegetation seems plausible, in view of the recent developments in the orchards of Colorado. It must be remembered, however, that the amount used per acre of orchard was several times the amount usually used on a field of potatoes; and in the case of potatoes, where a rotation is followed, bringing them on the same field only once in three or four years, it would take a much longer period of time for the soil to arrive to that stage now found in some of the poisoned orchards of the West.

In the one point of killing the Colorado potato beetle there is nothing much cheaper than Paris green, and the potato grower using it in a spray mixture should add a pound or two of lime to every pound of Paris green. If

Photo No. 18

Showing the diamond slot 4-row duster applying Bug Death to a 25-acre field of potatoes on the Johnson Seed Potato Co.'s farms, Richmond, Maine, season of 1912. Note the fine condition of the vines. This field was never sprayed with Bordeaux Mixture and kept green many weeks longer than fields nearby, which were thoroughly sprayed with Bordeaux.

Bordeaux mixture is used, the lime in the Bordeaux will be sufficient, the Paris green being added to the Bordeaux at the rate of one pound to each acre of potatoes to be sprayed. Paris green has no fungicide value, and its addition to the mixture is simply to combine an insecticide with the Bordeaux. Used in this way, it will adhere better to the vines than if used alone. Those who use it in a dry form will get the least injury to the potato vines by mixing it with land plaster (gymsum) at the rate of one pound of Paris green to fifty of plaster, dusting over the plants with any of the dusting apparatus that will do the work.

That it is not more generally used in this way is because of the fact that most of the machines on the market have not been a success in distributing it as it should be.

For one who desires to use Paris green, mixed with land plaster, will find the Diamond Slot two and four row duster (photos Nos. 18 and 19) equally as effective for putting on this mixture as for applying dry Bug Death.

The plaster has a beneficial effect on many soils. Paris green varies greatly in its killing strength, also in the water soluble arsenic it may contain, but this variation is not so wide as to cause the great difference in the killing of the potato bugs which so many farmers complain of. One pound per acre ought to entirely kill the bugs, if evenly applied, but I have seen many potato growers who had to apply from three to four pounds per acre at an application, and even the second and third application of this amount would not clear the vines of bugs.

I am inclined to the theory that under certain weather conditions it makes the vines distasteful to the bugs, and they pass through a period of time when they do not eat enough to kill them, while the vines growing new leaves soon give them a new feeding ground free of the poison. I have noted this same failure both with arsenate of lead and Bug Death practically as often as I have with Paris green; and as all three are effective in killing these pests when eaten by them, I can account for their seeming failure in no other manner.

The heavy amount spoken of above, however, should never be used, as the injury to the vines is too great, and may result in the entire loss of the crop.

The potato grower using Paris green should use as little as possible of it, and get as even an application as possible over the entire plant. With the Paris green and plaster

Photo No. 19

Showing a two-row duster at work in the author's home potato field, season of 1912. This two-row duster will distribute Bug Death or any fine powder very evenly over any plants in rows—2 acres of potatoes an hour can be easily gone over with it, doing fine work.

mixture, the evenness of the application is apparent at a glance, and a minimum amount of the green can be used.

ARSENATE OF LEAD

Arsenate of lead was the result of the demand for some poison as effective as Paris green, but without its injurious effects on foliage. It was used largely by the old Gypsy Moth Commission in Massachusetts for the spraying of trees infested with this pest. It has two advantages over Paris green, in that it will adhere much better to the leaves during rainy weather and that the injury done the vines is not so apparent. In my experiments with it, the loss in yield of tubers by its use was not over one-half that caused by Paris green.

One objection to it is that it is slow in its action in killing the bugs. I have seen fields after the third spraying with it literally swarming with larvae of the potato beetle.

It is more costly than Paris green and is equally dangerous to stock, and, as more pounds of it are used per acre, is open to the same objections as a soil poisoner as is Paris green. However, if I were obliged to go back to the arsenical poisons as a means of killing the potato-eating insects, I should use arsenate of lead in preference to Paris green, making several sprayings within few days' time, when the slugs were hatching out. In this way insects could be gotten rid of, with a minimum of injury to the plants by arsenical poisoning. As it has to be applied in the form of a spray, it is not so available for those not equipped with some spraying apparatus as is Paris green or Bug Death, either of which can be applied in a dry form.

BUG DEATH

Bug Death is entirely different from either of the previously discussed insecticides. It contains no arsenic, and while it will kill many kinds of insects, including the potato beetle in all its stages of growth, it is entirely harmless to stock or human beings. There is absolutely no danger of stock getting poisoned with it; no more than there is with road dust lime or ashes. But its chief value lies in the fact that it affords the potato grower, the market gardener, the fruit raiser and all growers of flowers a safe means of fighting a greater part of the insect pests, without the least

danger of injuring the foliage. There are hundreds of thousands of country people who need and have been looking for years for something along this line, which can be easily and quickly applied without any danger of injuring tender plants.

The author has been using Bug Death on his potatoes and garden truck for fourteen or fifteen years, using some seasons over a ton of it, practically all of which he applied himself, either with a horse-power sprayer or dusting it on dry. From this long experience, I feel safe in speaking very positively of the value of this material to any one needing an insecticide. In the growing of seedling potatoes, which have a very tender foliage, which is certain to be injured by the application of arsenical poison, and which are most certain to be injured by Bordeaux Mixture itself, I have been able to keep them in much better condition by the simple method of dusting them lightly with dry Death Bug five or six times during the season. This in spite of the fact that some of our scientific men in the State Ex. Stations ridicule the idea of Bug Death being a fungicide. As far as first cost, it is not as cheap as either Paris green or arsenate of lead, as much more of it has to be used. The retail price is $7.50 per hundred pounds, and 100 pounds is none too much to use on an acre of potatoes during the season, and in many sections will give as good results as is possible to get with Bordeaux Mixture, no matter how well made and thoroughly applied.

Bug Death can be applied in water through a sprayer, but I have never been able to get as good results in that manner of applying as I have in dry form. It is a decided improvement to Bordeaux mixture where one needs an insecticide with the Bordeaux. Used in this way, 15 to 20 pounds per acre at each application for three or four applications will give almost perfect protection both for the flea beetle, that scourge of the potato growers, and the Colorado beetle also. Fifteen to twenty pounds of Bug Death, added to enough Bordeaux Mixture to thoroughly cover an acre, makes a thick, heavy mixture, which will not wash off the vines when once dried on. In fact, after trying all kinds of insecticides, I unhesitatingly claim that Bug Death and Bordeaux Mixture gives the greatest protection, both for insects and blight on the potato, of anything yet produced as a spray mixture.

In spite of this, all things considered, I prefer to dust

the Bug Death on dry, especially the early part of the season. There are several reasons for this; first, there is sure to be more or less injury to the potato vines from the Bordeaux Mixture itself, varying in the time of showing according to weather conditions, but usually showing here in Maine in about six weeks from the time of the first application.

By dry dusting with Bug Death early in the season to keep the vines free of all insects, those who live along the Atlantic coast and near ponds and streams, where foggy weather is apt to make blight conditions very bad, can delay the use of Bordeaux Mixture usually into August, and thus to a large extent escape the injurious effects of the Bordeaux But sections with these conditions form but a small part of the potato-growing area of the country, and in most cases the use of the dry Bug Death will give all the protection needed, both for insects and blights.

The matter of getting water is a serious one to many, and costs a lot of hard work to any one spraying. **Again, when spraying, work should not be begun in the morning, when the vines are heavily laden with dew, but with the dry dusting many acres can be gotten over with the dry duster before it would be best to start the sprayer. Photo No. 18 shows the Diamond Slot four-row horse duster. As it is but a few seconds' work to fill this machine with the dry powder, four or five acres an hour can be easily gone over, thereby allowing the large grower to get over a large field long before the dew would be dried off enough to start a sprayer.**

Photo No. 19 shows the hand or two-row duster. This machine will apply dry powder like Death Bug very evenly over the vines, and two acres an hour can be easily gone over with it, doing fine work. This photo was taken September 5th, 1912, and shows the author and a part of one of his potato fields. This field has been gone over twice with the two-rowed machine, applying a total of 80 pounds Bug Death per acre in the two applications.

The photo showing the Diamond Slot duster applying Bug Death on a 25-acre field of the Johnson Seed Potato Co., Richmond, Maine, was taken August 30th, 1912. This field had nothing but dry Bug Death applied for either insects or blight, and was on September 1st, 1912, the finest field of growing potatoes of its size I have ever seen, and I have seen some of the finest fields grown in Aroostook

County, Maine, where soil and climatic conditions combine to make of a potato field a thing of beauty.

To sum up, those wishing to use something besides the deadly arsenical poisons will find Bug Death will free the vines of both the Colorado and flea beetle, and give practically the same protection against blights as Bordeaux Mixture. In addition, it will be found to be a positive benefit to the plants, which will be shown in the darker green of the foliage, and an increased yield per acre, varying from ten to sixty bushels.

Photo No. 20 shows the plant where Bug Death is manufactured. I want the reader to note photograph No. 4, showing an experimental plot of one-seventh of an acre on an old, run-out piece of land, planted without any commercial fertilizer or barn dressing, but which was heavily dusted three times during its growing period with dry Bug Death, a 100-pound keg being used, or at the rate of 700 pounds per acre. This amount was used not because it was necessary to kill or keep off insects, but to see the effect this heavy amount would have on the plants themselves.

FACTORY IS 360 FEET IN LENGTH AND HAS A YEARLY CAPACITY OF
3000 TONS OR MORE OF BUG DEATH.
DANFORTH CHEMICAL CO.
DANFORTH CHEMICAL COMPANY MANUFACTURERS OF BUG DEATH

Photo No. 20

Showing the Danforth Chemical Co's plant, Leominster, Mass., manufacturers of Bug Death, the only Insecticide made which does not contain arsenic.

There was absolutely no question but the large growth and perfect condition of these vines was due, to a great extent, to the heavy application of the Bug Death. I have noted the same effect times without number on many garden vegetables, especially melons, squash, cucumbers, tomatoes and eggplant. Many times the beneficial effects are so great as to be far beyond the small amount of nitrogen Bug Death contains could have.

There is a process in the economy of plant life, not yet investigated by the Ex. Stations, whereby a combination of materials different than those used in the composition of the arsenical preparations which will in certain stages of atmospheric conditions allow the leaves of plants to which it is applied to draw, in some-at-present unaccountable manner, plant food either from the air or soil.

In no other way can I account for the vigor of growth which so many times follows an application of Bug Death to growing plants. The writer has strongly urged the Ex. Stations in many states to take up this work, as it is of vital importance to the whole agriculture of the country; but, so far as my knowledge goes, I have yet to hear of the first instance where any effort has been made along this line,but the sole effort on the part of the Ex. Stations has been to push the sale of arsenical poisons, regardless of the effect on both plants and soil. If the farmers of the country want the Ex. Stations to work for their interest along this particular line, they will have to exert a stronger influence over them than has been the case in the past.

BORDEAUX MIXTURE

The general spraying mixture used on potatoes as a prevention of blights is Bordeaux mixture. It has been condemned by so many potato growers who have used it that there can be but little doubt but what it is not all the early advocates of its use claimed for it. Probably it has been more generally used by the potato growers of the State of Maine than those of any other section of the country. That there is a stronger feeling in the state today that it is not all that has been claimed for it would hardly be denied by any one familiar with the existing conditions. Potatoes rotted badly in Aroostook County in 1907, de-

spite the fact that spraying was general. In 1908, the season being dry and unfavorable to the spread of the spores of the disease, very little rot was found in the county. The crowning year for rot coming the next, or 1909, when those best able to judge claim that one-third of the crop rotted, many farmers losing nearly their whole crop, and resulting in a loss to the county, estimated by some to be around five millions of bushels. Some claim that the best-sprayed fields rotted the worst, while others claim, with equal vehemence, that spraying saved their crop, one probably being as near right as the other. Too many farmers have reported that their sprayed fields have rotted badly, while those not sprayed rotted but little, if at all, to waive them aside without consideration. That there are reasons back of all of this not yet understood there can be no doubt.

From my experience, I am inclined to believe that the vitality of the seed planted many times determines whether or not the crop can be saved by spraying with Bordeaux mixture. In writing this I have aimed to keep my own experience in the background, putting down as far as possible only known facts. But one experience of my own along this line might be of interest to the reader. I planted one five-acre field several years ago with seed which I knew to be lacking in vitality. This field was as thoroughly sprayed as it is possible to do the work. Eighty gallons of Bordeaux mixture was used per acre at the first application, two hundred gallons each at the second and third spraying and one hundred and thirty-three in the fourth, the last application being September 7th. Late blight or rot spread on this field after the second spraying, many leaves being affected all over the field. The third spraying seemed to check the spread for a time, owing partly to cooler weather. The fourth application had little effect in checking its spread, it being about as bad in one portion of the field as any other. The vines were thoroughly covered with the Bordeaux, yet the blight spread, and there was quite a per cent. of rotten tubers. Had there been a few days of as hot weather as we usually get in late September, there is but little doubt but nearly all the tubers would have rotted. If Bordeaux mixture gave no better protection to fields in general than it did to this one, it would be of but very little use to the potato grower. On the other hand, I am

satisfied that had this field been planted with strong, vigorous seed that the spraying given it would have entirely prevented the blight and rot.

There is a question whether the action of the Bordeaux mixture itself is not weakening the vitality of our potatoes, despite the protection it usually gives against blights. I have yet to examine a field in September that has been kept thoroughly sprayed during July and August that does not show leaf injury caused by the Bordeaux. This shows in a burning and browning and hardening of the leaves, and in some fields is a very pronouced injury. The later in the season the vines remain green the more this burning of the copper sulphate shows. Yet, when well made and intelligently applied, it will increase the crop of tubers in most any kind of a season, especially in the more Northern states. The making of Bordeaux mixture has a great deal to do with its efficiency in protecting the vines, and no doubt there are many using it who do not mix it in such a way as to get the best results. The old formula of six pounds of blue vitriol and four pounds of lime to forty-five or fifty gallons of water is seldom, if ever, used now by the potato growers in Maine. This did not carry enough lime, and the injury spoken of above caused the use of more lime and less vitriol. **The five-five fifty formula is used by many, while five pounds blue vitriol and six pounds of lime and fifty gallons of water probably is an even better one. The ready mixed Bordeaux mixture or ready mixed dry Bordeaux has not seemed to give as good results as the home-made.**

The new process lime manufactured for the making of Bordeaux does all right, but more of it should be used than of common lump lime. Seven to eight pounds of this should be used to five pounds of blue vitriol to get the same effect as six pounds of common lump lime well and properly slacked. As the new process lime costs more per pound, and more of it is needed to the same effect, it is more costly to use. For the small, and many times to even the large grower, the easiness with which it can be mixed up will save enough time to more than make up for the added cost. It is a good plan for any potato grower who plans to spray his crop to have a supply of this new process lime on hand. Many plans of making and mixing Bordeaux mixture have been given to the public, showing how the diluted lime water is contained

in one barrel and the diluted blue vitriol water in another, both being run into the spray tank through pipes or hose, where they mix together as they enter the tank. These are all right as far as they go, where water is handy and can be pumped up to a height which will allow this to be done. This is seldom the case in actual field work with the average grower. Probably ninety per cent. of the water used to make Bordeaux mixture has to be drawn to a greater or less distance to get it to the potato field. If the distance to get it there is more than a few rods, the quickest and most economical way is to haul it in large barrels on a farm wagon rather than in the sprayer itself. In this case it is much better to slack the lime and dissolve the blue vitriol in that section of the field where the greatest saving of time can be made when spraying. Stock mixture should always be made even for a few acres, and as both the lime and vitriol will keep indefinitely until mixed together, much time can be saved by so doing.

The following stock solution will make five hundred gallons of Bordeaux: Get two large barrels, holding fifty gallons each, dissolving in one of these fifty pounds of blue vitriol. There are two ways of doing this. One is to put the vitriol in a coarse sack and hang it into the barrel near the top, so that the vitriol will be only partly covered by the water. This is the usual way, but is not so satisfactory as the following: Get or make a box about twelve inches square and ten to twelve inches deep, tacking on the bottom of it a piece of brass or copper wire netting after removing the bottom. Nail two cleats along opposite sides near the top, so that the box can be set into the barrel resting on the cleats. This will bring the box down into the barrel some eight or ten inches, according to its depth. Pour the fifty pounds of blue vitriol which is to be dissolved into the box, and fill the barrel with water by pouring it through the vitriol. More than one-half of the vitriol will be dissolved in just filling the barrel, and as the bottom of the box is down in the water, the balance of the vitriol left in it is in the best possible position to dissolve quickly, and in an hour or two all will be found ready for use. If the box is made with copper nails and the netting tacked on the bottom with copper tacks, the box will last for years, and will save many hours of time as well as wasting of blue vitriol. We now

have fifty pounds of vitriol dissolved in fifty gallons of water, or one pound of vitriol to each gallon of water. In the other barrel we will slack sixty pounds of good lump lime. Pour two or three pails of water in the barrel first, then turn in the sixty pounds of lime. A good stirring paddle should be at hand, for the lime will begin to boil in a very few minutes. Care should be taken that this does not spatter into one's eyes. More water will have to be added, always keeping enough in so the lime will slack without burning. Ten to fifteen minutes will slack this to the consistency of a thick paste. If this can be done the night before wanted, it is better letting it set until morning before filling the barrel up with water, as it will slack better to be kept hot for a few hours. When needed, fill the barrel with water. This gives us sixty pounds of lime in fifty gallons of water.

When ready to spray, first fill the sprayer at least half full of clear water, then add five gallons of the blue vitriol water. If insecticides are to be used, they should be added at this time. Next, add five gallons of the lime water, give the pump a turn or two to start the agitator and stir the mixture, and if the sprayer is not quite full, fill it by adding clear water. This will make as good Bordeaux mixture as one can get, and at the lowest price.

As the operator uses the lime water out of the lime barrel, he can add more water, always keeping in mind to use all the lime the barrel contains in using the fifty gallons of blue vitriol. The object in adding more water to the lime is to so dilute it that it will readily pass through the strainer in the sprayer tank. This also does away with trying to strain out the coarse material, which we always find in our lime which settles in the bottom of the barrel. Thoroughly sprayed with a Bordeaux mixture made in this manner five or six times during the season by going over and back on the rows at each spraying, potatoes will seldom be badly hurt by blight and rot. When this does occur, the chances are that there are other and obscure causes that are back of it, like poor, weak seed, which should never be planted.

SPRAYERS

A sprayer should be thoroughly well built, with large pump capacity and a strong agitator working close to the bottom of the barrel or tank, keeping the mixture in perfect

suspension. Most machines are now made to spray four rows at a time, and on rough, uneven land this is as many as it is advisable to try to cover at once. On large, smooth fields, free from stones of any great size, six rows can be covered at a time, provided the pump has a capacity enough to keep the working pressure up to where it should be. A working pressure of at least 75 to 90 pounds is needed when the machine is working in the field with the spray turned on, whether spraying four or six rows at a time.

A sprayer that will not develop and maintain this degree of pressure day after day either is out of order or is lacking in pump capacity. The pump should be made entirely of brass and copper, and the plunger should be so made that the wear of both plunger and cylinder can be taken up by putting on the plunger leather or canvas cups. These will make the pumping capacity of the machine as good as new. Two or three days of continuous work will so wear these cups that the pressure will begin to fall, and many times before the operator realizes it, he will be doing inferior work, and another set of cups will need to be put on.

A sprayer needs a good deal of attention to keep it in first-class working condition. Many have fitted up for spraying their potato fields, and then for inferior work done have not received the returns they looked for, and therefore condemned the process. This is almost always either the fault of the operator, who fails to understand the proper working of the machine and keeping it in perfect working order, or of the machine itself.

Bordeaux Mixture is hard on the life of any sprayer, on account of the lime used in its making, and in the hurry of the work many fail to properly strain the mixture as it goes into the sprayer tank. This results in clogged nozzles, impatience on the part of the operator and unsprayed portions of the field, allowing both insects and blights to get a start. I have not yet found any nozzle equal to the vermorel for the potato field.

The pump should be fitted with two leads of pipe, a return pipe to the tank and the one leading to the nozzles, both being fitted with a stopcock. When starting for the potato field, after filling the tank, start the pump and open the stopcock leading back to the tank. This allows the agitator to thoroughly stir the mixture while the pump is pumping it back into the tank. When the potato field is reached, shut off the stopcock leading back to the tank, allow the

pump a few strokes to get up as much pressure as wanted and then turn on the stopcock leading to the nozzles. An allowance should be made of a few feet in entering the rows, in order that the nozzles may all get working in good shape by the time they get over the first hills when entering the rows. A little practice on the part of the operator in turning the spray on or off will enable him to spray the end hills when entering and leaving the rows as well as any part of the field.

A first-class power sprayer will be fitted with a waste gauge leading back into the tank, and so arranged that by a turn with a thumb nut the amount of pressure can be easily changed. This waste gauge should be set at all times so that it will give up and relieve the pressure on the pump before breakage occurs on any part of the machine. It also should be fitted with a pressure gauge, allowing the operator to see at all times the amount of pressure his pump is under. A good strainer should go with every machine, fitted with brass or copper wire screen of thirty meshes to the inch. This is fine enough, so that if nothing passes into the spray tank but what goes through this size mesh there will be no trouble in clogging of the nozzles. Some sprayers are fitted with a strainer containing a screen of too small surface, which is easily clogged up when filling the tank, especially when straining in the lime.

The aperture in the spray tank should be large enough to take a strainer containing at least twenty-five to thirty square inches of wire screen. This will allow surface enough, so that with a reasonable amount of care on the part of the operator there will be but little, if any, trouble in rapidly filling the tank. All of these things are of importance to the grower. Many times, with a small screen surface strainer, it will take longer to fill the tank with the mixture than it does to apply it to the potato field. This is a useless waste of valuable time at a season when every moment is precious, and causes a slighting of the work which would not otherwise happen. With a good four-rowed horse sprayer, kept in condition, as perfect work can be done on large areas as is possible for the small grower to do with a knapsack sprayer. Photo No. 15 shows a four-rowed horse-power sprayer at work.

SPRAYING

The importance of spraying potatoes as a preventive of

blight is overlooked in many sections. This is especially true in the case of late blight or rot. There is hardly a season, even when there is no late blight, that the extra yield from sprayed fields will not more than pay all cost of spraying. This being the fact, spraying becomes a system of crop insurance which the careful grower feels that he cannot afford to neglect.

Spraying, to be effective, must be carefully and thoroughly done. In ill-planted fields, with crooked rows and rows of varying distances apart, no perfect work can be done. The spray should be forced all through the vines, coating the under as well as the upper side of the leaves and stalks. Spraying is a preventive, not a curative necessity. For this reason, it should be begun before the blights are established on the plants, and this holds true for the larvae of the potato beetle as well. To do this work effectively demands much of a sprayer. The nozzles should not be set to point straight down, but a little forward or backward. The larvae of the potato beetle likes to get into the crown of the plants, feeding on the tender new leaves growing there. To be effective, our spray must be forced into the crown of the plant, while, at the same time, we want angle enough so that it will be forced among the stalks and under the leaves, coating both leaves, stems and stalks with the mixture. We should have pressure enough to have our spray come out of the nozzle just like a jet of steam. The nozzles should be as near the rows as they can be and get spread enough to the spray to cover the whole of the row. Many make a sad mistake here in not adjusting the nozzles to the size of the plants they have to spray, and really cover only a narrow strip through the center of the row. Others have their nozzles too high, and, while they cover the rows entirely, the spray has no force to it when it reaches the plants, and consequently it is not forced among the stalks. In this way the stems, stalks and under side of the leaves get but little benefit from the spraying, although to the careless observer the work looks to be perfectly done.

There can be no real, thorough spraying in going one way over the field. Some advocate, where the pumps are powerful enough to furnish plenty of pressure, the putting on of double nozzles, one pointing forward and the other backward, will give the same result in one driving over the field. While this is all right in theory, it doesn't work out as well in field practice, partly because it applies too much mix-

ture at once, without giving it any chance to dry on; and, again, the operator, unless he has had long practice, is almost sure to fail to have the pressure up at times when he enters the rows. This leaves the ends of the rows unsprayed, even with double nozzles, as double nozzles cannot spray with no pressure behind them. With the sprayer in good working condition, the operator, if returning on these rows, even with single nozzles, is certain to have plenty of pressure as he leaves them. In this way, the ends of the rows which he failed to spray on entering will at least get a more thorough spraying than if he had gone only one way, even with double nozzles. To go both ways with double nozzles takes too much mixture per acre and makes spraying too costly. The best results are obtained with the minimum amount of mixture by using single nozzles. Going over the field and letting the first application dry on, and then reversing, reaches both sides of the hills, and the small crown leaves, where the tiny slugs have congregated, have got two sprayings at different angles, which is practically certain to cover them and kill all the slugs.

Spraying should begin when the vines are from six to eight inches high. Fine caps should be used on the nozzles at this first application, as it saves material, and a sprayer holding sixty gallons can then be made to cover an acre, going both ways. If insects are plenty, the second application should follow the first in a very few days. It is sometimes better to make the first three sprayings inside of ten days' time, if the weather is very warm and slugs are hatching rapidly. These should be killed before any damage is done the vines. At this period of rapid growth the foliage is increasing so fast that plenty of unsprayed surface can be found in the crown of the plants by the little slugs as they hatch out. For this reason, three sprayings are sometimes needed to entirely rid a field from slugs. If this work is done as it should be, there will be but few bugs left to bring out a crop of slugs later in the season, and in the subsequent sprayings an insecticide may and probably will not be needed.

A field allowed to become badly eaten by either the flea or Colorado beetle is much more likely to be attacked by either the early or late blight than one kept free from them. This is also true of arsenical poisoning, which is much more likely to injure the plants if badly eaten by insects, especially the flea beetle. The free arsenic, acting on the raw, freshly

eaten edges left by these insects, seems to be much more harmful to them than it is to uneaten foliage. After the first three sprayings, the others can follow along at intervals of ten days to two weeks, according to weather conditions. Dry, cool weather is unfavorable to blight, and the period between the sprayings can be longer, while moist, hot weather, being favorable to the spread of the late blight or rot, would necessitate a shortening of the time between sprayings. There comes a time in the period of the growth of the potato when it seems to be the most susceptible to disease, especially the late blight; this is just when it is passing out of the blossom stage of its growth. If we can get it through this critical period without harm, it is a comparatively easy matter to keep the vines green until late in the season in the more Northern sections until killed by frost. This means a greatly increased crop, as the last few weeks the vines remain green is when the potato makes the most profit to the grower.

For this reason, it is advisable when the potatoes are passing out of the blossoming stage to use more gallons of mixture per acre than at any other time. On vines that thoroughly cover the ground not less than one hundred and twenty-five gallons per acre should be used at this time, and I frequently use more. Spraying should never be stopped because the vines cover the ground and will be broken and more or less trampled upon when driving through them. Vines that have got to this stage of growth will not be cut off badly by the wheels of the sprayer going over them. The rolling of them down by the wheels, while it looks bad, will hardly even bruise them except on side hills where the sprayer slides more or less down hill. When this happens a few will be cut off, but the damage done is infinitesimal compared with the good done in preventing blights and promoting growth of tubers. No one should hesitate to spray, even if the vines are so rank and tall that the rows can hardly be made out; a growth of vine of that magnitude certainly needs the protection given by a thorough spraying.

THE FLEA BEETLE

There is no insect that does greater damage to potato vines at times than the little black flea beetle. I had much rather have the Colorado beetle to fight than

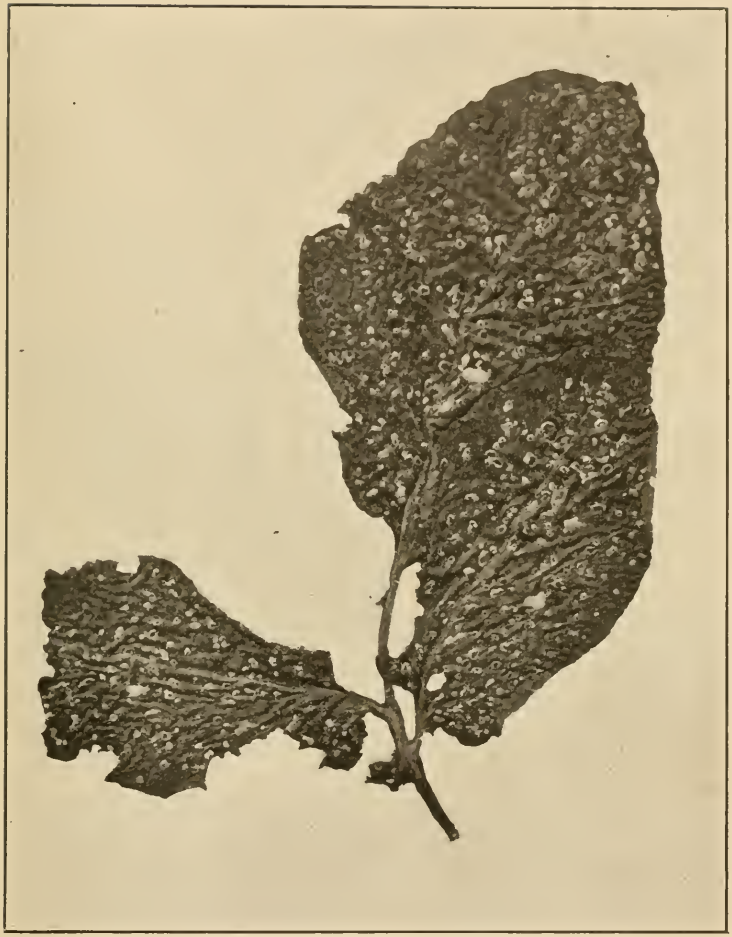

Photo No. 22

This shows the injurious effect of the flea beetle. The injury of this insect is one of the most destructive the potato grower has to contend with. Bug Death is the most successful insecticide to combat this ravaging and destructive insect.

this little pest. In fact, he does far greater damage before attention is attracted to his work than any other insect I know of. In my section of Maine there is an early brood, which usually comes the last half of June in great numbers. Frequently potato fields will show practically all their leaves eaten, as shown in Photo No. 22 by the time the plants are five or six inches high.

Fully one-half of the surface of the leaves have been destroyed as far as their use to the plants is concerned before the grower realizes what is being done. This could not happen with the Colorado beetle without being seen long before one-half of this damage could have taken place.

Potato vines eaten in this manner are much more susceptible to arsenical poisoning and the early and late blight and other fungous diseases. There is sometimes an August brood in Maine, and in some cases these are so plentiful that even a vigorous field of vines, which completely cover the ground, will be ruined by them in a very few days. Not only do they eat the leaves full of little holes, but eat in many places part way through, thus making little depressions. It is the settling of the Paris green into these little depressions, partly eaten through the leaves that causes the target-like marking shown in Fig. 17 of injuring due to Paris green or arsenical poisoning, and makes arsenical poisoning so much more pronounced on a field that is badly infested with the flea beetle. Its ravages also have a decided effect in causing the early blight; so much so that it seems reasonably certain to claim that the early blight would seldom, if ever, cause much loss to the grower unless the plants suffered a loss of vigor through the ravages of this pest and arsenical poisoning.

Again arsenical poisons do not kill this pest to any great extent, or, at least, do not seem to lessen their ravages. Hence Paris green should not be used when the vines are afflicted with the flea beetle unless it becomes necessary to use it to kill the Colorado beetle, as the Paris green, settling in the little holes, partly eaten through the leaves, helps along the injury to the vines and makes a bad matter worse. Bordeaux mixture, thoroughly applied, will keep them partly in check by driving them away.

There is no way I have ever found to protect my fields from the flea beetle like dusting them with dry Bug Death when the plants are damp either with dew or

right after a rain.

I have never been able to determine whether or not it was fatal to them or simply drove them away, but it makes but little difference to the potato grower, provided his fields are kept free from them, which the Bug Death will do far better than anything else I have ever used.

THE COLORADO BEETLE

The Colorado beetle is probably the best known of all the potato-eating insects. It seems to have been a native of Colorado, hence its name. When the settlers carried the potato into its home it seemed at once to form a particular liking for the foliage of this plant, and at once began to spread East in search of its new-found food. It reached Iowa in 1861, and Wisconsin in 1862, Illinois in 1864, Michigan and Indiana in 1867, Ohio in 1868 and Pennsylvania in 1870. Twelve years later it reached Nova Scotia, and has been a pest over the whole eastern portion of the country ever since. That it will ever disappear hardly seems probable, although it varies in number greatly in different sections at different times. It flies readily in bright, hot weather, but the distance it can cover in this manner does not seems to be known. From my observation, I believe it never flies in damp, cool weather, and the approach of evening or a sudden shower will precipitate it to the ground, regardless of where it may be. It can frequently be found washed up on the shores of lakes and ponds, sometimes in countless numbers, a sudden cooling of the atmosphere causing them to fall into the water in their flight across where they have miserably perished.

They winter by burying into the soil, coming out with the first real hot days of spring, and sometimes appear in such numbers on a potato field, where the plants are just breaking ground, that all growth made for several days, or even weeks, are eaten by them. It is at this stage of the growth of the plants that they are the hardest to combat, as there is so little leaf surface that it is practically useless to try to poison them. They mate at once, and egg laying commences within a few days if the weather remains warm, the little potato plants frequently having several hundred eggs on them when two or three inches high. If these plants can be covered up with

soil, it will spoil these first egg clusters, and in the case of very late planted potatoes many times will be all that is needed to free a field from them. The work of fighting them should never be delayed until damage is done the plants, as it will result in a loss of crop that will amount to many times the cost of the labor and material needed to rid the field of them. What to use in this work is described under Insecticides.

TREATMENT FOR SCAB

Scab is a fungus disease (Oospora scabies), growing on the surface of the tubers, causing rough pitted patches, or

Photo No. 23
Showing scab.

in badly infested soils these patches cover the whole surface of the tubers, oftentimes making the whole crop unfit for market. (See Photo No. 23.) Some varieties of potatoes are much more susceptible to scab than others.

The American Giant is noted for its scab-resisting qualities, but its cooking quality is such that in most markets, if bought at all, it brings a much lower price. As a general rule, the better the quality of the variety the more likely it is to be attacked by the scab fungus. This is not always true, however.

This disease is widespread and is carried to soils which are free from it by planting infected tubers. One of the methods of controlling scab is to plant seed free from it. With a system of crop rotation which will bring potatoes on a field only once in three or four years, little or no trouble will be experienced from its attacks. The scab fungus will not thrive in an acid soil, and although it may be present or even scabby potatoes planted in such a soil, the resulting crop would be free enough from it to sell readily in the market. We can lime a soil and sweeten it up to that point where clover will thrive, and still not have it sweet enough to prevent growing potatoes on it by reason of scab, if we will be sure to have the seed we plant free of the disease so as not to plant the scab along with the potatoes.

If it becomes necessary to plant any seed showing spots or patches, as shown in the cut, it should be disinfected. One of the methods to do this is to soak the tubers before cutting in a solution of formaldehyde. This is commonly called the formalin solution. It is not a very costly or time-taking job if gone about in a businesslike way. There are several methods of doing this, but the following will suit the farmer who plants up to 100 or 150 bushels of seed:

Get five large barrels holding from fifty to sixty gallons each and set them in a row out of doors, putting into each of them 35 gallons of water; add to this one pint of formalin of the standard 40 per cent. solution to each barrel. Put the potatoes into coarse bags (bran sacks are best for this purpose), tieing them near the top. This allows the potatoes to spread out in the bag, and by so doing three bags, holding one bushel each, can be gotten into each barrel, and the 35 gallons of the solution will completely cover the potatoes. The five barrels make it possible to have 15 bushels of potatoes soaking at a time. This is about all one man can attend to at once. Let these soak from one and

one-half to two hours. While this is going on, more can be sacked up and got ready to put into the barrels, as soon as the first lot is removed. In this way one man will pick up out of a bin and soak about 100 bushels in a day's time. The cost of the formalin should not be over a dollar and a quarter for the five barrels, and each barrel should soak at least 40 bushels of seed. When the potatoes are removed from the solution it is better to turn them upon the ground, one bushel in a place, and throw a bucket of clear water over them to rinse the solution off, as it makes them nicer to handle when cutting. When dried they can be picked up and put in bins again until needed for planting.

All bags, boxes or baskets used to handle the potatoes after being soaked should be previously dipped in the formalin solution to kill any of the scab fungus which might be on them; and if they are to be put back into a bin, a bucket of the solution and an old broom will allow the operator to thoroughly disinfect the bin before putting the potatoes back into it. When a soil becomes badly infested with scab it is a serious matter, and if the disease is to be eradicated it can be more quickly done if potatoes are kept off of it for some years and green crops grown and plowed under to set up a slight acidity, which will help to kill it out. Lime, ashes or heavy application of barn manure tends to sweeten the soil and promote its growth.

Sulphur has been used by many to dust over the seed when cut, and also scattered along the row when planting. With some this seems to be a perfect remedy, while with others it seems to amount to very little. That the condition of the soil itself has much to do with its effectiveness is no doubt true. Some authorities claim that spreading seed potatoes to sprout where the direct rays of the sun will strike them will kill the scab fungus.

When the scab fungus is in the soil, any treatment given the seed will not insure a clean crop, but only makes certain that we are not planting the disease along with our seed. Many times it may be present in a limited way in a soil favorable to its growth and not get to affect the tubers enough to hurt their market value from one season's planting unless the scab in good, vigorous condition is planted on the seed.

Land that is reasonably free from it will usually grow good market crops of tubers if a rotation is followed which

will bring potatoes on the ground not oftener than once in every three or four years. This is most sure to be the case if stable manure is not used on the field; but the humus-content kept up by plowing under green crops or a clover sod, and chemicals or commercial fertilizer used to supply the plant food needed by the potato crop.

One having scab on his seed potatos should read the chapter on "Selecting and Cutting Seed." If this is followed thoroughly and the knife disinfected as stated, the grower will have but very little trouble either with scab or many other diseases which now make potato raising on some soils a risk.

LATE BLIGHT OR ROT

The late blight or rot probably causes more loss to the Northern potato grower than any other disease which attacks the plant. As far as known, it lives through the winter only in the tuber itself, and many times it can be easily detected when cutting potatoes to plant, although it might be present in many of the potatoes cut and not detected even by an expert. It may affect only a small portion of the tuber, and, in cutting, the portion affected might not be cut through and, therefore, would not show even to the most expert observer.

If, when cutting seed, the cut surface shows black-like threads running through the tuber, it should be discarded, as this is more than likely to be the late blight, or rot, in the dormant state in which it passes the winter. It also can sometimes be detected by sunken spots on the surface of the tubers. These are usually irregular in shape and vary from mere spots in size to covering nearly the whole surface of the potato. These usually appear during the winter while in storage, and in some cases quite a percentage of a bin of potatoes will be found showing these spots in spring, when at digging time no trace of rot was found on the tubers in the whole field. When infected seed is planted and the soil and weather conditions become favorable to the growth of this fungus, it spreads to the surface by the roots and stalks. I have frequently found the whole root system and stalk below the surface of the ground badly affected when the thoroughly sprayed top showed no blight whatever, and a slight pull would break the stalk off just below the surface of the soil.

This is one reason why early spraying for the late

blight or rot is necessary, as it may be working towards the surface on the roots and underground stems when infected seed has been planted, and even the most critical observer could not detect it in the field unless an infected hill should happen to be dug out. If any seed piece planted was badly infected, the sprout or stalk springing from it is likely to come up weak and spindling. On the other hand, many seed pieces may be so slightly infected that the vigor of the sprout will apparently be but little impaired, and the field make a splendid growth and appearance.

If at about the time the plants are going out of blossom and sometimes before, if the weather becomes hot with frequent rains, the spores of the blight reach the surface, and if the vines are unprotected, they spread very rapidly over the leaves, and in a few days' time will turn a fine looking field into a mass of blackened, dying vines, with a very offensive odor.

If no rain falls from the time the vines become infected with the spores until they are entirely dead, and the unripe tubers in the ground have ripened off or hardened up, there is little danger of it. Tubers after they are thoroughly ripe seldom rot in the soil unless it becomes very wet. Again, a field that shows but little blight on the vines, perhaps none to the average grower, and keeps green until frost may have its tubers rot badly. This comes from the spores of the blight being washed from the leaves down upon the unripe potatoes, which they immediately attack.

A field can have its vines so slightly affected by the blight spores that the casual observer would not detect it, and still there be enough to wash down upon the unripe tubers and cause a bad case of rot in case of heavy rains.

A field can also become infected with blight by the spores being brought to it by the wind from a field perhaps miles away. In this case, it is usually detected on the leaves near the top of the plants. A leaf showing a portion turned black and drooping, with a white mold on the under side, can safely be diagnosed as affected with the late blight. If good, vigorous seed has been planted and the vines kept thoroughly sprayed with Bordeaux mixture, or thoroughly dusted with Dry Bug Death, see photos Nos. 18 and 24, beginning when they are only six to eight inches high, there is but little danger of

Photo No. 24

Showing the O. K. Champion Potato Digger No. 2 at work on the Johnson Seed Potato Co's farms, Richmond, Maine. This is one of the lightest draft, cleanest digging potato diggers on the market.

Worlds wonder potatoes yield 430 bushels per acre in 1912.

the grower losing his crop from the late blight or rot. If blight is once allowed to get well started on a field, there is but little hope of saving the crop.

The above-mentioned photographs show a part of a 25-acre field of potatoes on the Johnson Seed Potato Company farms at Richmond, Me., in 1912, which had nothing in the way of insecticides or fungicides applied to it but Dry Bug Death, and were in the best of condition on September 1st of any field in that section. The vines remained green until late in October, the last photo showing the digging of the World's Wonder October 22nd, 1912, the yield being practically 430 bushels per acre.

HARVESTING THE CROP

Potato harvest at best is hard work both for teams and man. The old hard work of hand digging is largely done away with by the modern potato digger, which will do fine work if cultivation has been thoroughly and properly done unless heavy and frequent rains keep the ground in muddy condition. This may and frequently does happen, and where the crop is on a clay loam soil no potato digger made will do good work or, in fact, do any work at all in mud. When these conditions do overtake the grower there is nothing left but hand digging with the potato or tined hoe.

The elevator diggers are most used and most practical and there are several makes on the market. As in showing the various other machines used in the fitting of the soil and the growing of the potato, I call the reader's attention to the photo No. 24 of the O. K. Champion Potato Digger No. 2 at work on the Johnson Seed Potato Co. farms at Richmond, Maine, taken October 22nd, 1912. This digger is manufactured by the Champion Potato Machinery Co. of Hammond, Ind.

This machine is of light draught and is easily drawn by one pair of good horses, and if cultivation has been done as it should be one man and a pair of horses will dig an acre easily in from two to two and a half hours, leaving the tubers all or nearly all on top of the ground ready for the pickers.

The form of the rows has much to do with any machine doing good work. The practice of the Maine grower, almost without exception, is to ridge his rows, but not too high or wide. This forms an ideal chance for any

digger to do its best work. If the rows are ridged too wide and high, no machine can handle the soil and separate the tubers out without a draught much too heavy for one pair of horses. This is especially true if the ground is in any way too wet. Thus, if level cultivation, or wide and high ridged rows confront the grower a large four-horse digger might have to be used, as it has a much larger separating capacity.

Such a machine, when the ground is in proper condition and the rows have been ridged about right, is not nearly as desirable for many reasons. First, the draught is much too heavy for one pair of horses, and a four-horse team, outside of the extra expense for the extra horses, will trample upon and cause more or less loss of tubers. Again, with fine conditions for digging, the soil will leave the machine too quickly, leaving the tubers to pass over the elevator with no protection from bruising unless the machine is run at a much greater depth than is necessary or desired.

A digger which requires four horses is unnecessary in most cases if proper attention has been given to ridging as it should be done.

With most late varieties which grow a large top which usually entirely covers the ground the rows should be not less than 34 to 36 inches apart. In ridging, planted this distance apart, it won't do to take the soil from centre to centre, as a too large ridge will be thrown up to work properly through any digger which can be drawn by two horses when the ground is wet.

Therefore the Maine growers' practice is to make a medium sized ridge as shown in Photo No. 14. This will work nicely through a smaller or two-horse digger and leave the tubers as clean and nice to pick up as can a larger machine which costs much more to operate. That a very large ridge may, in some seasons at least, be the means of producing a little larger crop of tubers I am inclined to believe. That this increase in yield will be enough to offset the extra cost of digging has not been my experience. Different sections of the country have different methods of handling the crop after being dug. The Aroostook county method is to pick into barrels, drawing these from the fields on low wagons or jiggers. This is a type of wagon little seen in most other sections of the country, but it makes a rapid, easy way to get the crop to the storehouse. Other

Photo No. 25

Showing the Aroostook type of storehouse. This depends on artificial heat passing up between the outer and inner walls.

sections use bushel boxes or sacks, which can be much more easily loaded on the high wagons used in many of the potato-growing districts, but for those sections where the crop is to be stored for winter or spring shipment there is no cheaper or easier method than having the pickers dump the tubers into barrels set at proper distances along the rows and drawing the filled barrels to the storehouse with the low wagon.

STOREHOUSES

Storehouses for the keeping of potatoes are a necessity where the crop is largely grown and not all sold from the field as dug. It is pretty safe to assume that new

seed would not have to be brought from the North every year in many sections where it is now done were the growers fitted with proper storehouses. Once in two years would be as often as new seed would have to be obtained throughout Pennsylvania and as far South as the Southern border of this state west through Ohio, Indiana and Illinois.

There are two ways to build a frostproof potato storehouse. The one most generally used in Aroostook County, Me., see photo No. 25, is to have a chance in the cellar or basement for a stove with double walls to the building, with the outer air space opening into the cellar or basement. Thus a very little heat will keep this air space above the freezing point, and with another air space between this and the potatoes, where the air is dead, potatoes can be kept free of frost with but little cost for heat, no matter how low the temperature may go outside.

Aroostook County, Me., gets a temperature from 30 to 50 degrees below zero every winter, but there is seldom any loss of tubers in the storehouses there by reason of frost. Such a house needs constant attention in cold weather, and is not the best form for the grower farther South. Some writers claim that a dry, cool cellar is better than a damp one for the keeping of potatoes. This is not so. The cellar should be cool almost to the freezing point, but there is less loss in weight if it is damp. For the grower as far South as Pennsylvania, Ohio, Indiana and Illinois, a house with a cellar under ground is, in my opinion, far better. Such a house is shown in photo No. 26. The upper part of this building is used for the storing of farm implements, fertilizer, sacks, etc.

The cellar walls should be either of stone or concrete, and the ceiling over the cellar should be plastered with concrete in order to keep the moisture away from the timbers. Unless this is done, the timbers will not last over from six to ten years. With a building as shown in the photo, the potatoes are drawn from the fields into the building and dumped through scuttles into the bins below, care being taken not to bruise them in so doing.

After the potatoes are in, the cellar should be cooled down as fast as possible until the desired point is reached. This can be done by keeping it closed during the day and opening it nights, when the temperature outside is

cooler than in the cellar. If the cellar is dug into the hillside, and proper precaution taken to keep water from coming in, there is no need of any floor, but the potatoes can be dumped right upon the earth bottom of the cellar. They will keep much better than on a wooden floor. I have seen many such that were cemented on the bottom. Unless this is necessary to keep water out, it should not be done, as it makes the cellar too dry for the best keeping of the tubers.

The nearer underground such a cellar can be the more even the temperature, and if the cellar is kept closed as spring approaches, the tubers can be kept until well into the spring before sprouting. The darker the cellar is the better will the tubers keep their quality; but some way must be provided for light when it is desired to remove them.

Such a cellar as the above will keep tubers without freezing with no artificial heat whatever. The writer's own cellar has now been built ten years, and I have seen the glass go to 25 below zero, and hang around the zero mark for weeks at a time without a tuber being touched by frost.

Where a building is not needed over the cellar for storage of farm implements, a reinforced concrete roof can be made with scuttles to dump the potatoes through to get them into the bins. These can be raised as high as wished and the whole roof covered with soil and grass allowed to grow upon it. The roof should be made water tight by a thin coat of cement before being covered. Such a cellar should be dug into the side of a hill or knoll, allowing teams to drive over the cellar easily to dump into it, while on one side or end it should be on a level of the bottom of the cellar, allowing a team to be backed right into the cellar when the doors are opened, or, at least, allowing the potatoes to be taken out on the level. This saves lifting both in storing and removing from the cellar.

By having a storehouse on the above plan, a grower can keep his seed stock in much better condition, and many times, by so doing, he can produce enough larger crops to pay for the whole cost of building such a cellar.

Again, if buying Northern seed, by having a proper chance to store and keep it, he can purchase in the fall, when it is usually cheaper in price. He is then sure of having his seed on time in the spring, which means

much in many cases, as delays often occur in getting seed from the North in early spring.

MARKETING THE CROP

The marketing is largely a matter of color, size and quality. A roundish white potato with a shallow eye is what most markets demand today. These should be well sorted and graded as to size. It is uniformity of size that takes the eye of the buyer.

There always should be at least two grades, and if there are many large tubers of a pound or more in weight, it is many times advisable to make three grades. The first grade should be all nice, smooth tubers, practically free from scab, prongs or any form of roughness. The largest of them should not be much if any over 12 to 14 ounces and the smallest not below 5 ounces. This is as great a variation in size as ought to exist in any lot which the grower expects to have graded as firsts and to bring the highest price.

All above this grade in size that are good and smooth will usually sell for a higher price per bushel than could be obtained if both of these grades were mixed together. There is almost always a good market for these large tubers if they are smooth and nice in appearance and are good clear through. The fear that they are hollow or black in the centre or core is about all the reason the buyer has against them; but in their favor they have large size, which readily commends them to the maker of potato chips or the hotels or restaurants where fried potatoes are served. Large tubers are peeled with less labor and waste. Could nice, clean stock, running from 12 ounces up to two pounds, always be obtained, there would certainly be a good demand for it at good prices. In the third grade would be all those below five ounces in weight down to those of the size of large hen's eggs that were good and smooth. Many prefer this grade for baking purposes, as they will bake quickly and the flavor is equal to any.

The average grower does not have enough of either of the last two grades to establish and maintain a trade in them, and in an average neighborhood there are so many different varieties grown that it would be impossible to work this in a co-operative way. Still there is no question but what potatoes graded and put upon the market in this way would return to the growers more money and give the consumer

better satisfaction.

Any section where potatoes are largely grown ought to have a co-operative organization among the growers, not only for marketing their crop, but in the purchase of seed. This organization should have a building ample for its needs with facilities for loading cars right at its doors. The growers should draw in their potatoes and have a corps of experienced men to sort and grade them. The cost of this would be a little more perhaps than the grading in the field; but the extra price would much more than offset this extra cost, as no field-sorted stock is ever perfectly graded. By this method the men doing the grading having no interest in one man's lot above that of another would grade uniformly, something absolutely needed to build up a reputation and get prices above the general market.

By having such an organization the varieties planted can be limited to those best suited to the locality in point of quality, yield and market demands. Any section which can establish and maintain a reputation for choice, well-graded stock not only obtains the highest price at all times, but has a demand for its product even when there is a glut in the market. This point alone is many times of the greatest value to the grower, enabling him to dig and dispose of his crop at good prices even in an overstocked market.

The prices obtained by the Long Island, N. Y., potato growers above the general market prices well illustrate this point, as they frequently get from fifty cents to a dollar more per barrel than the general run of potatoes are selling for. There is hardly a section where potatoes are grown, where a right system of intelligent and broad-minded co-operation in selecting a few varieties best suited to that particular locality and having the product grown, properly sorted and graded, in which the returns could not be increased at least 10 to 15 per cent.

THE HOME GARDEN

A chapter on "The Home Garden" seems out of place in a work on the culture of the potato. Yet nearly every grower of potatoes is directly interested in a "Home Garden," from which his table can be supplied with the choicest of fruit and vegetables. The high cost of living is something that every one must face, and there is no

spot upon a farm where more can be got for the time and labor expended than a properly laid out Home or Kitchen Garden. I believe the neglect so often noticed on many farms of any pretense along this line is, to a large extent, due to the inability of most farmers to fight the garden insects in a quick, economical manner.

Nothing has been tendered them but arsenical poisons by most agricultural writers and Ex. Stations, and it was pretty nearly an even chance for the grower whether to let the insects kill his garden truck or for him himself to kill both truck and insects by an application of some of these poisons, usually Paris green.

This was particularly true of squash, cucumber and melons, to say nothing of eggplant and many other vegetables of the garden. Hence I shall confine myself almost wholly to those plants and vegetables whose growing is the most hazardous by reason of insects.

One of the most delicious of the products of the garden are Melons, both Water and Musk. These need light, warm soil, and in the more northern states at least the spot selected should slope to the South or Southeast, as a greater degree of heat will be obtained, and heat and sun are essential to their growth. The land should be finely cut up with the harrow before plowing, and a heavy application of barn dressing be applied and plowed in, but not very deep. The writer uses a high-grade potato fertilizer, with a part of its nitrogen in the form of nitrate of soda, running at the rate of one-half ton per acre into the rows with the potato planter, the disk coverers covering this, and with the leveling attachment following, the rows are smoothed down level and all done at one going over with the planter, the rows being six feet apart for watermelons and a little less for muskmelons. This might not be room enough in the south, but is plenty for Maine conditions. The great trouble with watermelons in the North is to get the seed to come up quickly. The seed is usually so dry and hard that in our Northern States there is not heat and moisture enough to germinate the seed properly, and a poor stand of plants is usually the result. After many trials with different methods, I have used the hot-water idea for the last five years with not a single failure. Watermelon seed are so hard that soaking them for a day or two in tepid water is not enough. Again, there seems to be more or less germs of

Photo No. 26

Showing the frost-proof cellar type of potato storehouse. This type is far better for the more southern sections, as potatoes can be kept much later in the season without sprouting.

different diseases that live through the winter on the seeds ready to attack the plants as soon as they begin to sprout. Five years ago it occurred to me to use hot water at first when I put the seeds to soak. This can be almost scalding hot when poured over the seeds, but the seeds should not be allowed to stand in scalding water but a very few seconds, just long enough to kill any germs that might be upon them, but not long enough to injure the vitality of the seeds themselves. This is no job for the heedless or careless man; but in my experience of only five years, when I have used the hottest water, I have got the best results. After this scalding process the seeds should be put into real warm water and allowed to soak for from two to four days, the water being grad-

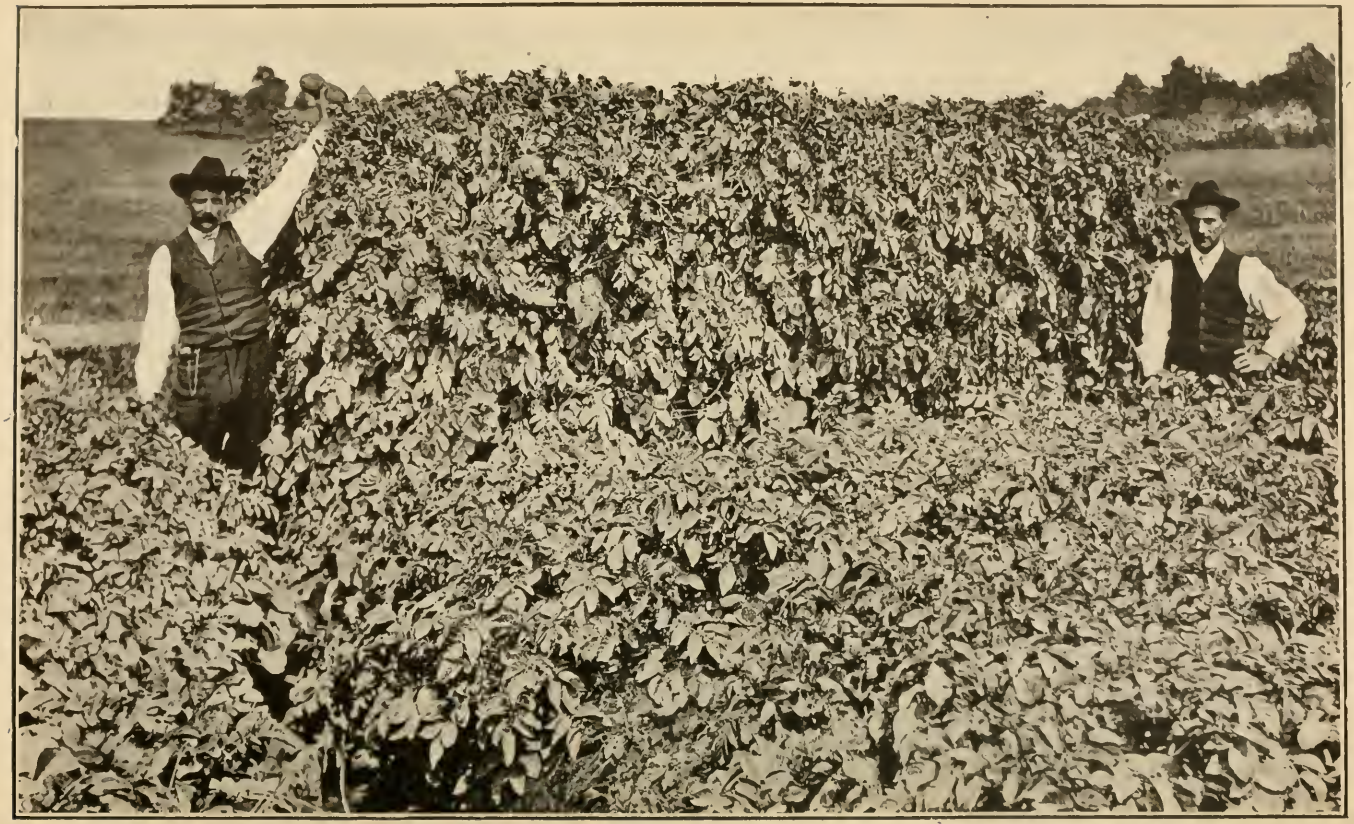

Photo No. 27

Showing the development of the vines of the Norcross potato trained over a trellis. The fore part of the picture shows the development of a two-year seedling on the originating grounds of the Johnson Seed Potato Co., Richmond, Maine.

ually brought down to about the temperature of the air and soil conditions out of doors. In planting, I follow the rows as left by the potato planter, and with a round pole from one to one and one-half inches in diameter laid upon the row and with the foot pressed into the loose soil. This makes a depression about one inch deep, with the soil packed in the bottom. This will insure moisture along the bottom of this little row where the seeds are to lay, and seeds that have been soaked must not be planted in dry soil where there is no moisture. A little care and these pole furrows can be got very straight. I plant Watermelon Seeds not over 4 inches apart along these rows, and cover not over one inch deep. I have never failed in this manner from having a perfect stand of plants, except once on one variety, where the seed was bad. This leaves our melon rows only an inch or so wide when the plants first break the ground, and the cultivator can be worked so closely to them that the cost of this part of the work is very small.

When the plants get well started, thinning should begin. There is always danger from cut worms, which is the reason the seed is sown so thick along the row, for, with any method of fighting the cut worm, he is most sure to get a good many plants before the worms can be all killed. After all danger of insects is by the plants should not be left nearer than three feet apart in the rows.

The most active enemies to melon plants both water and musk are the flea beetle and striped squash bug, both of which can be entirely controlled by the frequent application of dry Bug Death. The same duster as is shown in photo No. 18 can be used only now, but one row at a time can be dusted, the rows being so far apart. By narrowing up the width of the dust the machine will drop there will be but very little waste, and it is only a few minutes' work to cover an acre of melon plants in this manner.

They should be dusted early in the morning or late at night when damp with dew. There is another pest sometimes called the wilt beetle, which causes the plants to wilt and die, and which may not attack them until the vines have made quite a growth. There will be but little trouble with this pest if the vines are kept dusted, as they should be, with the Bug Death, as long as the machine can be used without too much damage to the vines

by the wheel running over them, and by the time this will happen the vines will be largely out of danger.

One of the surest watermelons to grow in the Northern states is the Coles Early. It is a good eating melon, but too tender for shipping; but that is no drawback for the "Home Garden." The "Halbert Heney" is the sweetest and finest flavored melon of them all, and, while small, will grow most years as far North as central Maine if on light, warm soil and in a sheltered place.

The Keckley Sweet is another fine melon, much larger than the Halbert Heney and nearly as good flavored. I have grown specimens of the Coles Early to weigh 32 pounds and Keckley Sweet 25 pounds here in Maine, which is larger than needed for home use.

In the case of muskmelons, where the seeds are thin, and in some cases have split open more or less, it will not do to use the water as hot, as it will upon the harder shelled dry watermelon seed. The two objects in using hot or nearly scalding water on watermelon seeds is, first, to soften up the hard shell of the seeds so that they can sprout quickly, and, second, to kill the germs of any disease that might be upon them. With muskmelons the last is the only reason, as there is but little trouble in getting a stand of plants if the seed planted is good, and with thin-shelled seed like muskmelons care must be used in order not to kill the germ of the seed when scalding to kill the germs of any of the melon blights which may be upon them.

Cut worms and the flea beetle like muskmelons much better than watermelons; hence, when planting muskmelons, the seed should not be dropped over one and one-half to two inches apart in the rows. This seems like a great waste of seed, as these should be thinned out to not less than 30 inches apart in the row after all danger from insects is past. The cost of seed is not very great, and with both water and muskmelons the time of planting is very short in our Northern states, and if the first planting fails to give the proper amount of plants needed the whole season will have been lost. There can be no set time for planting either, as the ground must be warm before it is any use to plant melons. As a rule, May 25th comes as near as any date can be specified, but I have planted a week earlier with fine results, and with the Granite State Muskmelon as late as June 15th, and got fine

ripe melons weighing four and five pounds by September 8th, but the Granite State melon is the only one I have ever had that will do this. In fact, I have never planted any of the other varieties after the first week in June and received any crop.

The Granite State is the most sure of any of the muskmelons, and if planted side by side with the "Miller Cream" for a few years will take on the good quailty of the "Miller Cream," while still keeping its old shape and size. Next to the Granite State would come the "Miller Cream." This is the finest eating melon I have ever tasted when grown to perfection. It should be planted never been able to have it grow properly planted later as early as the ground and weather will permit, as I have than June 1st. The Granite State will make a good crop in any season I have ever seen here in Southern Maine, but it is the only one that will. The "Miller Cream" will in about four years out of five, and so will some of the "Netted Gens" or "Rocky Fords." It is but little use to plant anything but the "Granite State" and "Miller Cream" as far North as Maine, but these two are all one needs or desires.

SQUASHES

In planting squashes, the same general system of preparing the soil is followed as in planting melons.

What barn or stable dressing that can be spared is spread over the patch, and either harrowed or plowed in, and some commercial fertilizer used in the drill the same as for melons. In fact, I find this to be about the best method for most garden crops, as much time is saved and all vegetables will get a quick start. The squash rows are run six feet apart, and the seed is pushed into the soil about 1½ inches with the fingers and about two feet apart in the row. There is not as much danger from cutworms with squashes as with melons, but if they are known to be present the seed should be planted thicker. Four feet apart in the row is about right to leave the squash plants. The flea beetle does not attack the little squash plants as they do muskmelons, but the striped squash bug will be a great deal worse.

If the little plants are dusted two or three times with Bug Death none of them will be lost. I do not think I

ever lost a squash plant when kept dusted with Bug Death, and if dusted with it before the bugs come they will not light upon the plant at all. Hence it is very important to dust them as soon as the plants break ground. With plants as scattered as they are in a squash patch, the best way is to take a piece of cheesecloth or burlap and make a small bag, putting a pound or so of the Bug Death in it, and with a little jerk or shake over the plant it will be well dusted. This should be done early in the morning or at night when the plants are wet with dew. With this method I have gotten nearly three tons of fine squash from one-eighth of an acre of ground, and it is rare that the yield will be less than six tons per acre.

Squashes should never be planted near melons, as they are apt to spoil the flavor of the melons.

CUCUMBERS

Cucumbers are planted in the same manner as melons, with the seed dropped as thickly in the rows, but only thinned to one foot apart in the row, and the rows can be as near together as three feet. I like the drill method for all garden truck, and by keeping the seeds in a straight line when they are small, there is but very little of the soil which cannot be stirred by the cultivator, keeping the garden free from weeds with the least possible amount of hand labor.

Bug Death should be dusted on the cucumbers as soon as they break ground, for the flea beetle will get at these plants nearly as quickly as muskmelons. Many who raise cucumbers for the pickling factories claim that several dustings with the Bug Death after the vines get to a bearing age will prolong their fruiting season from two to three weeks. Unfortunately, the writer has never grown cucumbers in a large way, but only for his home use, but they grow and bear fruit until killed by frost. If the claim of those who grow them for the pickling factories is well founded, it is certainly worth the trial for this purpose, as the vines can be dusted with the same duster used for potatoes and with very little waste of the Bug Death if the rows are in drills.

CONCLUSION

In conclusion, allow me to thank you for your attention and say that the methods, both in the home garden and

potato growing, which I have had the pleasure of bringing to your notice, have been worked out in the field by myself, and do assure you that if you will follow to the letter my instructions, the result will be a good paying crop of tubers in most any season, wet or dry, from Maine to Michigan.

I have many points herein in the culture of the potato mostly overlooked by potato growers, thinking it of too little importance, and which, to my mind, lead to a real loss.

The methods of preparing the soil are correct. If the seed is handled as I have above outlined, there will be almost a perfect stand of plants in any season; and the method of fertilization keeps the plants supplied with plenty of available plant food well balanced the season through. Thus you have the whole scheme—very simple, is it not? Yet I venture to say that there will be thousands who read this book who will so improperly fit their ground and fertilize that there will be weeks at a time in a dry spell when their crops cannot get a tenth part of either the water or plant food absolutely necessary to make a normal growth.

Feed your crops as you know you must feed your stock, and the increase will be accordingly. If the author is wrong, get after him.

Yours truly,

E. A. ROGERS,

Johnson Seed Potato Company,

Leominster, Mass.

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